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Complex Structural Detailing

AN interesting example of that type of structural design and detailing which tests the resourcefulness of designer and detailer is the Orpheum Theater in Boston. The required clear lower floor area was obtained by supporting the entire balcony framework of cantilever trusses and diagonal girders on a long, deep truss. A study of the general plan and of the details of connections, reproduced on page 287 of this issue, will indicate some of the problems which arose, and the method of solution. The limiting requirements set by overhead clearances, openings for doorways, etc., further complicated the design, and explain the unusual outline of the main truss. The use of Bethlehem H-sections for the main chords of the long-span roof trusses is claimed to have resulted in economy in material and in simplified details. The structure contains well-devised solutions of difficult problems and merits the careful study of structural engineers.

Houses of Cards

A NEW YORK BUILDER examined by the coroner's jury after a structure on which he was working collapsed, killing two people and injuring seventeen others, admitted that he did not know the requirements of the building code with reference to the proportions of the mortar ingredients. It was further shown that in an endeavor to skin the construction as much as possible there were various violations of the architect's plan. The instance brings nothing new to the attention of those familiar with the work of cheap contractors and with the type of apartment houses which are going up in so many of our cities. The owners desire to make their money go just as far as possible, regardless of the quality of the resulting structure. They figure on first cost only, and hope to dispose of their holdings long before heavy maintenance charges must be met. One good result should come from the disaster—a determination of all who have supervision or authority over such construction to be particularly suspicious of that class of structure, to insist upon rigid inspection and prompt stoppage of work when it is not in conformity with the building regulations. Laxity will sooner or later lead to a repetition of the New York experience.

Facts About Concrete

CONVINCING EVIDENCE that the work being done by the U. S. Bureau of Standards is of great value is presented in Technologic Paper No. 58, on the strength and other properties of concrete. The pamphlet reports investigations of a comprehensive character, made from the standpoint of requirements in actual construction and stimulated by the desire to answer scientifically questions concerning the effects of materials and manipulation upon the properties of the product. The abstract and conclusions presented on page 283 of this issue can only suggest the variety of the tests made, and the nature of the more important results. Two conclusions of practical importance should be strongly emphasized: First, that fluid concrete, so often used on construction work, probably develops only one-half the strength which the ingredients are normally capable of producing; and, second, that great economy results from proper proportioning of the aggregates and the use of large-size stone in plain concrete. These facts are not new, but the strong array of exact independent data presented should convince contractors and engineers of the soundness of the theories which this journal has in the past so strongly supported. It is ridiculous to require cement manufacturers to spend money in increasing the fineness and cementing value of their product by 10 to 20 per cent when misuse of the product in fabrication may decrease the strength by 50 per cent. This investigation is further valuable in the emphasis it places upon the necessity for testing the concrete that goes into a structure, under conditions duplicating construction conditions. Real evidence of fitness to carry stress comes only from such tests. The possibility of economies, through the use of properly proportioned aggregates, should stimulate the making of field tests and result in an improved product.

A Barrier Not Raised

UNDER the Clayton act it is illegal for competing firms to combine or co-operate to regulate prices. That section of the law prevents American manufacturers of a given product from pooling their interests in foreign trade promotion. Without such co-operation, however, it is impossible for small manufacturers to enter successfully into the foreign field and withstand the competition of government aided German firms and of British, French and Dutch export houses of great financial strength and long experience. The Clayton Act was passed, presumably, for the protection of the American consumer. It was not intended to aid foreign manufacturers in their competition with us in our export trade. That is, however, just what it is doing. An attempt was made at this session of Congress to secure legislation which would exempt combinations formed solely for export-trade purposes from the provisions referred to. Congestion in Congress, however, and the opposition of a member of the House have made it impossible to reach the measure at this session. Our foreign trade, therefore, must stumble along as best it can burdened with this weighty handicap. The unfortunate feature of the postponement is that the present is the best time ever afforded the American manufacturer to establish himself in the foreign field. Before Congress meets again or can act peace may have been declared and the situation radically altered. The measure was urgently needed. Its sidetracking is a detriment to the entire country.

Typhoid and Accident Insurance

CAN TYPHOID FEVER, contracted by employees as the result of drinking impure water furnished by their employer, be classified as an "accident arising out of the conduct of the business"? This is the question which the United States Circuit Court of Appeals, Ninth Circuit, was called upon to decide in the case of the Aetna Life Insurance Company vs. the Portland (Ore.) Gas & Coke Company. The defendant insurance company issued a "contractor's employer's liability policy," insuring the plaintiff against expense resulting from accident claims. Employees of the gas and coke company contracted typhoid fever from drinking water furnished to them by the plaintiff. The court held that this was an accidental injury within the terms of the policy and that the insurance company was liable. The decision is one which has an important bearing upon the cost of construction work.

Eccentric Column Loading

VITALLY affecting column design is the question of what provision should be made for eccentric loads. The question lies in the region of indeterminate problems, because of the uncertainty regarding end conditions in mill-building columns and the effects of continuity in the framework of office buildings. The discussion of this question by Mr. Fleming on page 296 of this issue leads to the conclusion, after the more exact formulas are presented, that approximate methods, using ¾ to 9/10 of the computed bending moment for pin-ended conditions, give satisfactory values for these types of buildings. In this connection it is of interest to point out that certain handbooks have published incorrect formulas for the bending moment in mill-building columns. These formulas include the entire eccentric moment Pm, without the reducing ratios a/l or d/l which appear correctly in Mr. Fleming's equations. The customary use of a 20 per cent higher unit stress for the extreme fibers of eccentrically loaded columns is advocated by Mr. Fleming. He presents the results of studies of the involved subject of bending produced by eccentric loads in the columns of steel office buildings, and his statement of the general practice of designers and the discrepancy between theoretical formulas and such current practice raises a question deserving further discussion: Are the fundamental assumptions upon which these theoretical analyses are based sufficiently exact to throw the burden of proof upon the practical designer when he does not conform to the results of such analyses? The Engineering Record urges free expression of opinion on this point.

Sewage Disinfection

WE appear to be entering an age of disinfection. The element chlorine is looking up. In the form of calcium hypochlorite, or bleaching powder, and more recently as the element itself, in the form of liquid chlorine, its application to public water supplies has become widespread in this country. Used under proper conditions its benefits are unquestionable. Being successful in this field there is a natural tendency to extend its use to other fields. To some extent it has been used for the disinfection of sewage and sewage effluents. The latest suggestion is that oysters be disinfected with calcium hypochlorite after being taken from polluted beds. The practicability of this is described by William F. Wells, of the U. S. Public Health Service, in a recent number of the "Public Health Reports."

The extension of chlorine disinfection to new fields must be made with caution. This method of destroying bacteria, while often efficient, has limitations which may not be safely disregarded. The paramount virtues of the hypochlorite method of water disinfection are cheapness, simplicity and availability. Virtues, however, may become vices. It was soon learned that this method was too simple. The idea became prevalent that a few barrels, or tanks, with stirring and measuring devices for applying the solution to water, was all that was required. This was wrong. Brains are required, and constant, patient attention to the simple devices. In times of emergency simple devices like these will receive the attention that is necessary, but after the emergency has passed interest is likely to lag and the process becomes intermittent and unreliable. It would be possible to mention the names of cities where this process has broken down under such neglect and where the germs of typhoid fever succeeded in getting by. One of the chief reasons why the use of liquid chlorine is better than bleaching powder for permanent use in water disinfection is because the devices require a higher grade of attention—although not more attention, measured in terms of labor.

Another virtue of the use of chlorine for disinfection is the rapidity of its action. Although not instantaneous, it is measured in seconds rather than in hours. Bacteria which come within its range are speedily killed. This virtue likewise has its failing. Apparently there is no second blow. It is a case of now or never. If bacteria succeed in passing by this one ordeal they remain alive. In water which contains organic matter the chlorine soon loses potency as a germ killer.

From the foregoing it follows that a rapid and intimate mixture of the disinfecting solution or gas with the water is absolutely essential. There is much room for improvement in this detail of the method, and the disinfection of water in suction pipes, in pipes under pressure, in flumes, and at the inlets and outlets of basins offers a series of problems which must be carefully considered, each by itself. Accidents in the disinfection of water resulting in outbreaks of typhoid fever have already occurred from the failure to obtain proper application of the chemicals, although these have been due more frequently to interrupted service than to imperfect mixing.

Another interesting method of failure of disinfection recently occurred in one of our large lake cities. In order to protect the consumers against the possible taste and odor of chlorine in the water a neutralizing chemical was used, thiosulphate of soda. This was added at such a short-time interval after the disinfectant that the action of the latter was interrupted before it had accomplished its work. This is said to have been the cause of an outbreak of typhoid fever in the city.

The chemical disinfection of sewage has always made a strong appeal to sanitarians. Unquestionably it has possibilities of usefulness, but in making application it must not be forgotten that here again we must consider the fleeting character of the reaction. The solution of bleaching powder or liquid chlorine kills those bacteria which it can quickly reach, and only those. In water the bacteria are present as free individuals or in small chains or clusters. Their surfaces are exposed to the destroying agent. In sewage they are partly free and partly enmeshed in lumps of organic matter. In the process of chemical disinfection only the free bacteria and those on or near the surface of the lumps are killed. Those within the lumps are so protected that they may remain alive until the action of the chlorine has spent itself. Later the disintegration of the lumps may liberate the bacteria which survived. It has been suggested that liquid chlorine has a greater power of penetration than calcium hypochlorite. If true this would be important, but thus far no evidence in this direction has been obtained. Judging from its rapid action in water its greater penetrating power may well be doubted.

There appear to be but two ways of overcoming this difficulty of disinfecting solid particles. The first is to increase so greatly the quantity of disinfectant used that a sufficient amount of the active substance will remain until penetration of the masses, or their partial disintegration, has occurred. The second is to remove the suspended matter from the sewage before disinfection—that is, limit disinfection to sewage effluents. Perhaps some intermediate combination of these might be made to produce the maximum economy, namely, a partial removal of the suspended matter and an increase in the dose of chemicals over that required for a clear liquid. Here as in all cases the process to be adopted must be based upon the required character of the final effluent. The earlier experiments in this direction were made with calcium hypochlorite and the removal of suspended matter by sedimentation and filtration. We now have a new possible combination, namely, liquid chlorine for disinfection and the activated sludge process for clarification. This combination does not alter the main elements of the problem, but it must of necessity change the value of the constants. It is to be hoped that one or more of the experiment stations may not lose the opportunity to obtain new evidence along this line of sewage treatment.

Prizes for Plumbing Theses

IT IS A FACT which few will venture to deny that plumbing fixtures and plumbing equipment generally are not designed from the standpoint of economy, but rather to promote safety and luxury. Elaborate devices and systems of pipes are installed in order to protect the air of houses from the supposedly dangerous sewer air, while bowls, faucets and all sorts of devices are introduced to embellish bathrooms and make the necessary fixtures for water supply and waste disposal attractive. Insofar as this contributes to the use of water, to cleanliness and to artistic features of our homes and public lavatories, it is a good movement. That clean-looking and attractive plumbing fixtures tend to produce cleanly habits and thus promote health is almost self-evident. On the other hand many of the modern fixtures are lavish in the use of water. Sewer air, although objectionable, does not disseminate the germs of disease. Trapping can be carried too far.

There appear to be several reasons why plumbing continues to remain complicated, in spite of the passing of the sewer-gas theory, and even to become more complicated. Dealers are naturally desirous of selling plumbing supplies, and the labor unions are naturally desirous of cultivating the field for labor. Public health authorities, zealous for the welfare of the community, have allowed regulations prescribing elaborate designs to be put in force, not always realizing what it means to the house-owner in dollars and cents.

A more important reason, perhaps, is the lack of interest which has been taken by engineers and sanitarians. The whole subject of plumbing has been left in the hands of those who profit by selling materials or labor. Perhaps the worst feature of the situation is that the young men from our technical schools apparently take little interest in the subject. Last year a prize of $200 was offered to the students of Harvard University and the Massachusetts Institute of Technology for the best essay on some topic relating to plumbing design or the materials used in plumbing systems. Not a single student entered the contest.

This year the donor has decided to throw open the contest to students of other schools where the subject of plumbing is taught and even to persons who are engaged in the practice of plumbing. Three prizes are to be awarded for the best theses, one to be competed for by instructors, one by students and one by plumbers. Details regarding these prizes will be found in the news section of this issue.

Why should the engineer take an interest in plumbing? Because it represents an annual expense of many millions of dollars; because the great size of the modern steel building has increased the complexity of designs so that they require engineering skill; because there is here an opportunity for applying the principles of efficiency to everyday life; because it is desirable that there be better co-operation between the business and the professional interests of the country; because the details of house plumbing are the connecting links between the water and the sewer systems and good sanitation is needed in the interest of public health and comfort.

It will be interesting to see what topics are chosen by the contestants for the Nelson prizes, for the field is left wide open. It may be the economical design of a wash basin, or a discussion of non-siphoning traps, the relative advantages of cast iron or steel soil pipes or the necessity of maintaining the running trap on the main house drain. There are topics innumerable.

Rejecting a Hard-Won Principle

AT THIS WRITING the most engrossing subject before the American public is the railroad controversy. It is still likely to be the paramount public question when this issue of the Engineering Record reaches its readers. The storm has long been brewing. Conferences between the railroad officials and the brotherhoods were of no avail. Then the federal board of mediation and conciliation failed and now the President of the United States, unable to bring the contending parties to an understanding, is appealing to Congress for legislation which will avert the impending disaster.

There is much talk in the press as to whose will be the responsibility if the strike should come. Last week the President was the favorite candidate for the rôle of scapegoat, though he was valiantly trying to unload the threatening burden on the railroad executives. It appears that the original guilty party would escape from his due meed of blame. Now, however, the public's mind is clearer. The bringing of the controversy before the President has aroused the interest of the dullest citizen. The setting was dramatic and attention has been comparatively easy to get. Both sides have had their say and the public, if deceived before, now comprehends the issue clearly. Newspapers which heretofore have failed to grasp the meaning of the "eight-hour basic day" have, during the last week, presented it correctly in their editorial columns.

Even the most heedless citizen, therefore, knows where the responsibility for the strike, if it should come, must lie. The employees throughout the negotiations have steadfastly refused arbitration on the main issue of the controversy—their demand that they be given ten hours' pay for eight hours' work. They have deceived the public—it appears even that they have deceived the President of the United States—into believing that they were contending for an eight-hour working day. On that false ground they won much sympathy. The advantage was only temporary. A reaction came when the truth became known.

From the very beginning the railroad officials have shown a conciliatory attitude. They were willing to give and take upon the merits of the controversy. In June a conference was held with brotherhood leaders, but it was impossible to secure a fair discussion of the issue with them. The leaders were unyielding on the main point in controversy. Then by an unfairly worded ballot, which compelled the employees to declare in favor of the basic eight-hour day, the men authorized the brotherhood leaders to use their judgment. The chiefs thereupon reiterated the demand that they should have all they asked for, or the trains would be stopped. Another conference was held at the request of the railroad officials. It proved fruitless. The officials then, not the employees, appealed to the federal mediation board. Again the railroads were in a conciliatory mood, the men stubborn in their refusal to discuss the main issue.

Despite the fact that labor has fought for a generation for the principle of arbitration, the brotherhoods have in this controversy rejected the principle. They claim that their demand for the eight-hour basic day is not arbitrable, apparently on the ground that a shortening of hours is vital to their welfare. As has been pointed out, however, the demand is in fact not for a shortening of hours, but for an increase in wages. The men are willing to arbitrate their "time and a half for overtime" request, but not the wage increase demanded under the cloak of a shortening of hours.

But should a demand which seriously affects the finances of the railroads be non-arbitrable? The public has set limitations, through the Interstate Commerce Commission, to the earnings of the railroads. They are at the mercy of the public on the one hand. Shall they be allowed to be at the mercy of one group of their employees on the other?

One would think from the stubbornness of the demands that the brotherhoods were representing all of the employees of the roads. As a matter of fact their membership includes only 18 per cent of the total number of railway workers—though they received 28 per cent of the total wages. Shall the brotherhoods' wage-increase demands be non-arbitrable without giving these other 82 per cent their day in court? The other employees are now awakening to their situation. Some 80,000 of them have signed a petition asking that steps be taken so that their livelihoods will not be interfered with. They have not demanded more pay or shorter hours. That they are awakening to the position in which they are placed by the brotherhoods, however, is apparent. They have rights which surely have some relation to those of the unyielding brotherhoods. Arbitration might shed light on that relation.

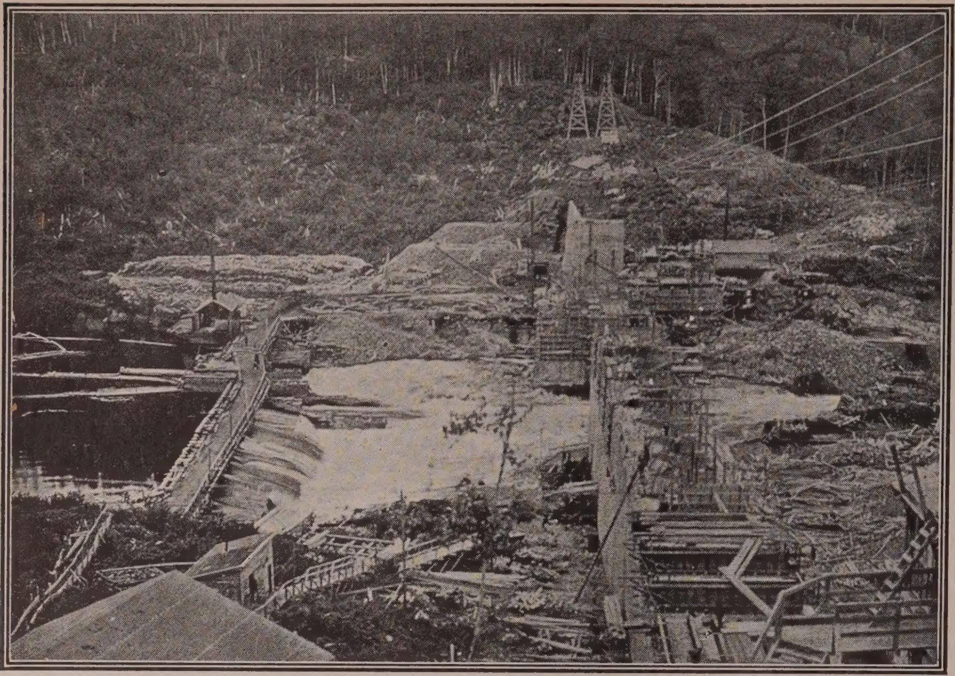
Instead of being objects of sympathy, which they were when their demands were wrongly understood, the brotherhoods are now standing forth in their true light—as enemies of American industrial peace. They have rejected the medium, built up through long time and much stress, by which industrial controversy can alone be satisfactorily settled — arbitration. They have tried to carry labor back a generation and to put force in place of conciliation. They have adopted the ways of industrial war rather than of industrial peace.

The strangest feature in the whole controversy is that the President of the United States, claiming he was an advocate of arbitration, should concede to the men their major request and demand of the railroads that they concede a ten-hour rate for an eight-hour day, leaving only the minor demands to arbitration. The railroads were right in refusing to accept the President's terms and, in the opinion of this journal, the country will stand behind them in their refusal.

Yet, true to the conciliatory attitude they have borne throughout the controversy, they have countered with reasonable requests. They are willing to set aside a fund which would represent the difference between present wages and those demanded under the eight-hour basic day, leaving to the decision of an arbitration board the disposal of the fund so created. As an alternative they are willing to grant the President's demand if assured that a rate increase will be given them should investigation show that the increased wages would cut them below a fair net income. To each of these demands, as they became known, the brotherhoods have rejoined their outright refusal. Their course has been consistently one of rejecting arbitration; the railroads', one of accepting it.

Whose, therefore, will be the responsibility if the strike should come?

As has been frequently said with reference to situations arising from the present European war, "peace can be purchased at too high a price." In the judgment of this journal there is no way out for the railroads except to meet the test, to stand where they have stood from the beginning—for arbitration — and let the strike come. Theirs is not the responsibility, and the American public knows it, despite the fact that the President has tried to make them the scapegoats. The issue would have been thrown into clearer light if the President had actually stood for what he claims to stand for—arbitration. By taking an unneutral attitude—untenable in a mediator—he has strengthened the men in their unreasonable position. He must bear some responsibility for the strike. Had he put the employees' attitude clearly before the country, shown up their refusal of an impartial arbitration, instead of siding with them on their major demand, it is hardly conceivable that the chiefs of the brotherhoods could have stood out against public opinion. To our mind the President, in his address to Congress on Tuesday, has unfairly placed the onus on the railroads, while the spirit of his message savors of opportunism and "peace at any price."



THE OLD LOG DAM ABOVE, WHICH DROWNED A SERIES OF RAPIDS, WILL BE BLOWN OUT

Concrete Dam Far from Railroads Built Largely with Materials at Hand

Sand Washed from Hillside, Quarry Opened at Top of Gorge—Interesting Conditions Govern Design of 70,000-Yard Structure for Stream Control

TO BUILD a large concrete dam across the head of Ripogenus Gorge on the West Branch of the Penobscot River in northwestern Maine, 45 miles from the nearest railroad, has required the utilization of every local resource. The boilers are fired with wood cut on the sides of the gorge. A fully equipped sawmill above the dam site supplies all form lumber. A traprock quarry has been opened at the top of the gorge on the south side, and the crusher, sand-screening and concrete plants are strung in order down the hillside to the end of the 850-ft. dam, for the construction of which twin cableways and derricks are being used. Cement and reinforcing rods—the only construction materials brought in in large quantities—are transported over the motor-truck freight road described in the Engineering Record of Aug. 19, page 237.

Unusual conditions dictating the construction for regulation purposes only of a dam at what might seem, to engineers unfamiliar with the conditions, primarily a site for power development, have presented an interesting design problem.

DAM AIDS IN MAKING PAPER

On the headwaters of the Penobscot and Kennebec rivers, in the vicinity of Moosehead Lake, the Great Northern Paper Company, owner of the dam, cuts annually almost a million logs for the manufacture of paper. Roughly four-fifths of these are "driven" down the streams flowing into the West Branch of the Penobscot, then through Ripogenus Gorge and down to the company's three main mills at Millinocket, Dolby and East Millinocket. A labyrinth of natural lakes enlarged by numerous timber dams makes possible control of the stream flow to secure water for carrying down the logs. All of these dams, however, are comparatively low, except that at Chesuncook, 3 miles above Ripogenus, which is one of the largest timber dams in existence, and the only one above Ripogenus designed for storage. The other dams make available little water beyond that required for the purpose of log driving.

Consequently, after the log drive is over each year there is not enough water in storage completely to regulate the river flow for power development at the mills. Below Chesuncook, however, there is considerable fall, these rapids being at present covered by Ripogenus Lake, a small body of water impounded by a timber dam at the head of the gorge. By constructing a modern concrete dam below this wooden dam, it was possible by raising the level of Chesuncook Lake 4 ft. to El. 940 to secure an available drawdown of 53 ft., 28 ft. of which can be drawn from the area above the Chesuncook dam. Even should the reservoir be left at the level of the lowest log sluice after a dry log-driving season, there would still be available 35 ft. of water. Chesuncook Lake is already 35 miles square, and the new lake will have an area of about 45 square miles. As the entire capacity of 18 billion cubic feet above the old dam, in addition to the 10 billion cubic feet added to the reservoir capacity by the new dam, will be available after blasting out the old timber structure, ample capacity for regulating the flow over the entire year will be secured. Moreover, by constructing a tunnel to the foot of Ripogenus Gorge, a head of 240 ft. can be developed if conditions should ever arise creating a market for the power. The country, however, is not adapted to manufacturing, there are no towns of size within many miles, and the company's developments already in operation are ample for its own needs. Therefore the only power developed at the dam will be the 45 kw. necessary for electric operation of the gates, log sluices and a small traveler handling the spillway stoplogs.

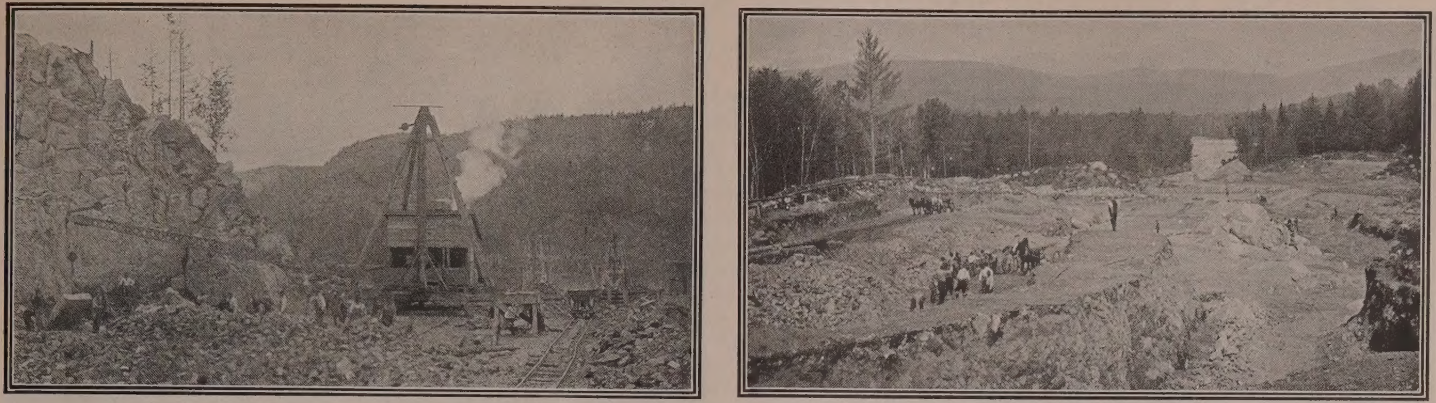
LOG SLUICES COVER 17-FOOT RANGE

Drop gates, releasing only enough water to carry the logs, are a feature of the two log sluices. These sluices are set side by side in the north end of the dam, the 16-ft. gate with its sill 11 ft. below high lake stage and the 12-ft. gate with its sill 19 ft. below this datum. Each gate is set in a concrete flume of the same width. These flumes come together and discharge into the river about 300 ft. below the dam. South of these sluices are the four gates for controlling the river flow. These have a combined clear width of 38 ft., sufficient to provide water for the mills until the lake stage reaches El. 887, 2 ft. above their sills. The gate openings are entirely lined with cast iron, as it was estimated that concrete would be eroded at the velocity developed by discharging under full head.

For the remaining length the crest of the dam stops 8 ft. below high lake level, or at El. 932. At El. 945 is a concrete roadway across the dam carried on piers between which are seated stoplogs up to El. 940. The spillway openings total 450 ft., sufficient to pass the maximum recorded flow of 23,000 sec.-ft.

The dam is built on traprock, the joint

PULP LOGS GOING THROUGH THE UNCOMPLETED SECTION ON THE SUMMER LOG DRIVE



LEFT, QUARRY ABOVE CABLEWAYS AND CONCRETE PLANT; RIGHT, SLUICING THOUSANDS OF YARDS OF GLACIAL DRIFT TO SECURE SAND

cracks of which are being grouted solid to an elevation 50 ft. below the footings.

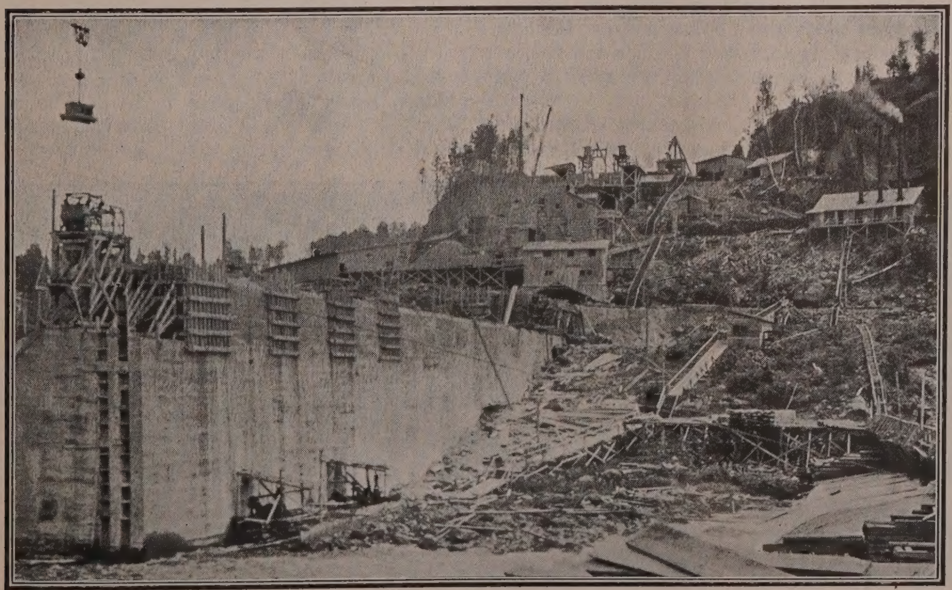
PLANT LAYOUT TAKES ADVANTAGE OF SITE

The construction layout can be readily grasped from the accompanying photographs. Traprock quarried at the top of the south side of the gorge is loaded by a traveler into cars feeding a gyratory crusher. From this the stone drops to secondary crushers and thence to the bins over the two 1-yd. mixers. East of these bins is the cement house, receiving cement from the motor trucks, level with its roof, and discharging it by means of gravity rollers to the mixer platform below its floor. Over this house is a rope conveyor with pans which transports the sand from the team dump to the hoppers over the mixer. The mixers discharge into cableway buckets. These are dumped into the forms direct or are rehandled by derricks, for the dam proper. For the roadway, the buckets discharge into movable hoppers and the concrete is distributed in carts. The south half of the dam and the north section to the south side of the sluice gates have been built with little cofferdam work. As soon as the sluice gates are finished, and the log-driving season is over, a crib dam will be thrown across the main channel, the river diverted through the sluice gates and the remaining section of the foundation finished. It is expected that the present season will see the completion of the project.

The only sand found after a thorough search of the lake bottom and the surrounding country was contained in a glacial deposit of sand, clay and boulders 2 miles below the dam. Pumps were installed below the gorge on the river, and an 8-in. pipe line delivering 1500 gal. per minute run to the top of the pit. After clearing the pit and stripping the surface of boulders and vegetable matter, two channels were cut, down which the material is washed to two large basins each holding about 400 cu. yd. The flow of water and the slope of channels and basins are adjusted so that most of the small boulders are dropped above the basins. Practically all of the sand and pebbles lodge in the basins, while all of the clay and vegetable matter overflows the brush dam below each basin and is carried off into the river.

A large force of men and teams are required to remove the boulders, shovel the sand and transport it to the dam where the pebbles are screened out and run into the stone bin. Blasting is frequently resorted to, as the stream through the pipe line, discharged more than 100 ft. above the river, is not under great pressure and depends for its eroding power on the fall in the channels cut for it. Between 20 and 50 per cent of sharp, coarse granite sand is reclaimed from the material sluiced. The cost is higher than the price of sand at several points in the state, but is still below even the cost of transportation of sand from the nearest rail point.

Most of the construction equipment was brought in during the winter on sleds. A large part of it was hauled across the ice on Moosehead Lake from Kineo in the cold winter of 1914-15.



CONCRETE AND CRUSHING PLANTS ARRANGED ON HILLSIDE ABOVE DAM

A camp with two mess halls, accommodations for the 350 men employed and cottages for the men in charge, foremen and office force is located upstream from the dam on the south bank. The dam is now being completed by the forces of the Great Northern Paper Company, of which Garret Schenck is president. J. T. Mullen is in charge of the project as superintendent. H. S. Ferguson, consulting engineer, designed the development and is supervising its construction. He is represented on the work by E. W. Prouty, resident engineer.

Worn Macadam Road Repaired by Tar Spraying

Inexpensive Equipment Employed to Distribute Tar Under Pressure—Detailed Cost Figures Given

By ROBERT H. McNEILLY
Assistant Professor of Civil Engineering, Vanderbilt University, Nashville, Tenn.

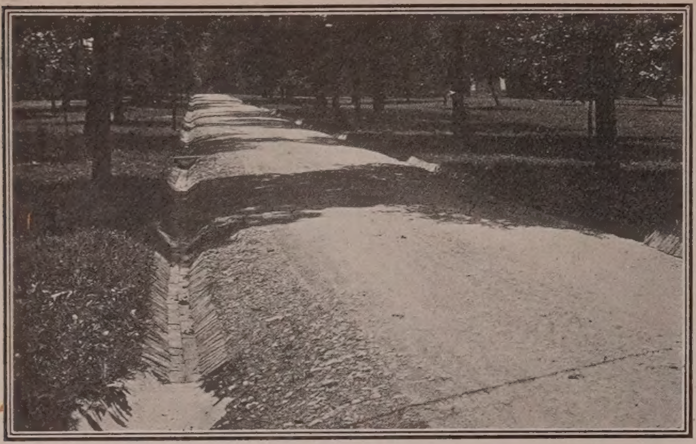
ONE of the most puzzling problems which confront the highway engineer is how to repair a macadam road successfully, without excessive expense for scarifying, rolling and clean surfacing stone, when it is determined to treat the road with oil or tar.

On the campus at Vanderbilt University, Nashville, Tenn., we had a road which was in a peculiarly favorable condition for the application of a light tar. This, it is thought, will serve not merely as a dust preventive, but will act to prolong the life of the road for several years.

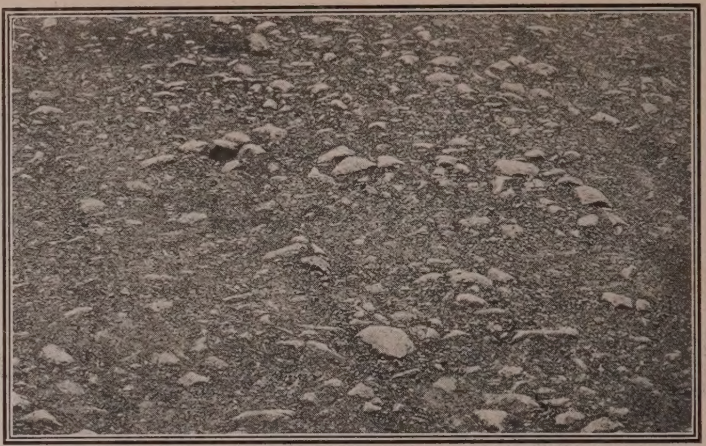
Picture 1 shows a general view of this road before treatment. It will be noted that the road is on a steep slope, but carries practically no drainage except the water which falls on its own surface. It was rebuilt about five years ago with a waterbound macadam surface of a peculiarly cementitious limestone. Picture 2 indicates how almost every particle of the binder has when it is determined to treat the road was on the point of going to pieces. On the day when these pictures were taken, difficulty was experienced in finding half a dozen large stones actually displaced in the road surface, while two weeks later, when the work was done, more than 50 such stones were swept out of the road.

EQUIPMENT INEXPENSIVE

The road was first swept clean, then Tarvia B, a low-carbon tar, fluid at ordinary temperatures, furnished by the Barrett company, was applied cold by an inex-



1—CONDITION OF ROAD BEFORE TREATMENT



2—EVERY PARTICLE OF BINDER REMOVED BY WASH

pensive equipment developed locally by the Uncle Hiram Roofing & Paving Company, which furnished the labor. The apparatus for applying the tar is shown in Picture 3. An ordinary four-wheel wagon has a 500-gal. tank mounted on it. To this is attached a truck which carries a 2½-hp. gasoline engine, which operates a geared water pump of the single-acting, plunger type. The purpose of this pump is merely to pass the tar, which is siphoned out of the tank, through its suction valves into its pressure chamber. The gasoline engine, at the same time, drives a small air compressor which maintains a pressure of 175 lb. per square inch in the rather large air dome of the pump. The pressure is controlled by a safety valve, which discharges back into the tank if the working pressure is exceeded. This air pressure serves to atomize the tar which is applied to the road through a hose, which terminates in a long gooseneck, with a spray at the end. The total cost of this apparatus need not exceed $500. It will be noted that the equipment is quite similar to a spray-painting outfit.

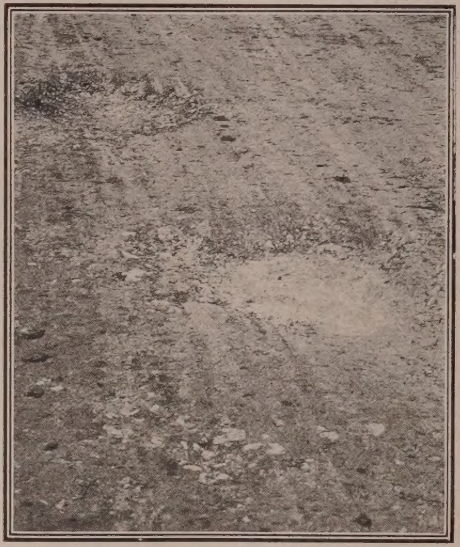
ANALYSIS OF CRUSHED GRAVEL

	Per cent retained
On ¼-in. mesh sieve	3.6
Between ¼-in. mesh and 10-mesh sieve	51.1
Between 10 and 20-mesh sieve	19.3
Between 20 and 40-mesh sieve	8.4
Between 40 and 100-mesh sieve	9.3
Between 100 and 200-mesh sieve	3.2
Passing 200-mesh sieve	5.1

In operation the team pulls the tank and truck about 20 ft. at a time. Then the brakes are applied and the road oiled up to this point, when another move of similar length is made.

The road treated was 595 ft. long and 14½ ft. wide—an area of 933 sq. yd. The time taken to apply the oil was 1 hour 53 minutes, or the rate of application was 8¼ sq. yd. per minute. On larger and continuous work, a speed of 10 sq. yd. per minute can easily be attained.

As the tar was applied, crushed gravel, furnished by T. L. Herbert & Sons, was spread by hand, following close behind the tarring. This crushed gravel is very coarse, and even the material that passes the 200-mesh sieve appears sharp under the microscope. The sieve analysis is shown in the table.



5—POT HOLES DEVELOPED IN IMPROPERLY CONSTRUCTED BITUMINOUS ROADS

This crushed gravel comes from the crusher much drier than river sand and is thus bonded by the tar the more readily. Eight cubic yards were used on the job, which was equivalent to 0.85 cu. yd. per 100 sq. yd. of road surface. This appeared to be rather too heavily applied, and ¾ cu. yd. per 100 yd. of road surface seems to be a more rational quantity. Following the practice developed in Alleghany County, Pa., the gravel was not rolled in, as experience has shown that the ordinary traffic is decidedly more successful in bonding the surface material. Picture 4 shows the detailed appearance of the surface after the work was complete.

The total amount of Tarvia B used was approximately 275 gal. for 933 sq. yd. of road surface, or 0.3 gal. per square yard.

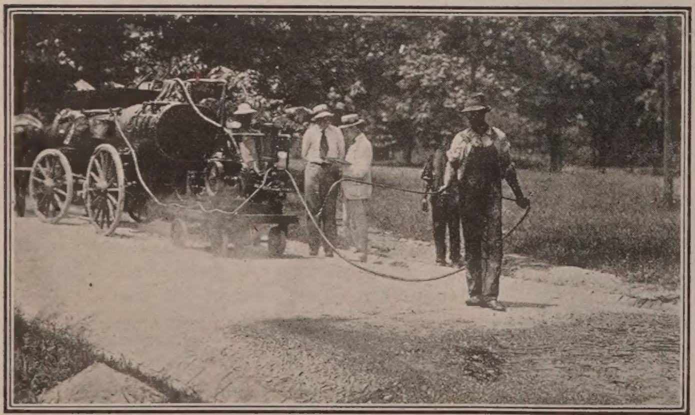
The cost of the normal operation of tarring a road in this manner is as follows:

COST OF TARRING ROAD

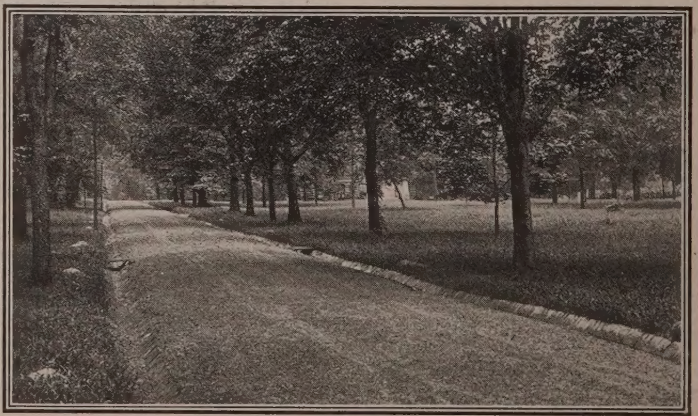
Labor	Per day
1 foreman	$3.00
1 engineman	1.50
1 spray man	1.50
4 laborers, sweeping and spreading gravel at $1.35 per day	5.40
1 team and driver	3.50
Gasoline, etc	1.30
Total cost of application per day of 9 hr.	$16.20
Materials, per 100 Square Yards	
30 gal. Tarvia B at 9 cents	$2.70
¾ cu. yd. crushed gravel, at $1.50	1.12
Total	$3.82
Cost of application per 100 sq. yd.	.30
Total actual cost to contractor per 100 sq. yd.	$4.12

Assuming a rate of application of 10 sq. yd. per minute, this is equivalent to a total cost for application of 30 cents per 100 sq. yd.

In this connection two interesting pictures are submitted which show some asphalted roads which were more or less a failure. These roads were constructed on Vanderbilt campus in 1910, and were the



3—INEXPENSIVE APPARATUS FOR SPRAYING TAR



4—APPEARANCE OF SURFACE AFTER TAR AND GRAVEL TREATMENT first penetration-method roads attempted locally. Since that time local contractors have become equipped with proper apparatus for the application of bitumen, hot and under pressure, and thousands of square yards of this type of road have been built in Nashville. Picture 5 shows how pot-holes developed in this road, which was constructed by the penetration method, using asphalt of about 14 mm. penetration. Nearly 2½ gal. per square yard of road surface was used and the total cost of resurfacing, rolling and treating with asphalt was approximately 45 cents per square yard. The "picking up" of this road, shown in photograph 5, is thought to be largely the result of too much asphalt on the surface, this asphalt having been applied by heating in an open kettle and applying by hand from coal scuttles. Limestone screenings were also used as a surfacing, which partly "killed" the asphalt, due to their large content of very fine dust or "flour." Picture 6 shows how this action of "killing" the oil occurred, causing the asphalt to crumble where the road was not subject to travel.

6—ASPHALT "KILLED" BY SURFACING OF LIMESTONE SCREENINGS

These last two pictures show in a marked degree how our knowledge of this method of road-building has improved since 1910, when these roads were rebuilt, and also, in a more marked degree, do they show the effect of having the local contractors equip themselves with feasible apparatus for doing this class of work.

S. A. Weakley, junior engineer, U. S. Army, took the pictures which illustrate this article.

British Columbia Railway Aid

Bonds to the value of $2,000,000 will be floated at once by the Province of British Columbia, Canada, to enable the Pacific Great Eastern Railway to complete its line through to Prince George. The issue will be sold under authority granted by the last British Columbian legislature, whereby the province is empowered to borrow $10,000,000 for the purpose of assisting the line. Part of the loan is for enabling the railway to complete work already undertaken. Men have been sent north to Clinton, B. C., and from that point track will be rushed ahead along the grade. It is expected that the steel will reach Prince George some time in the fall.

Complete Tests of Mortars and Concretes Reported by U. S. Bureau of Standards

Results of a Most Comprehensive Series of Investigations Into Effects of Single Variables Have Practical Significance

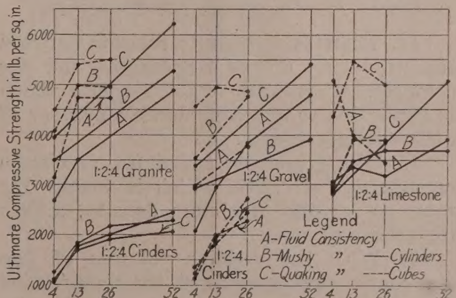
RESULTS and conclusions based on 20,000 tests of mortar and concrete specimens are given in Technologic Paper 58 of the U. S. Bureau of Standards, in which is reported probably the most comprehensive and practical series of investigations into the effects of various factors upon the strength of concrete ever made. By varying one factor at a time, experiments were made to determine accurately the effects of consistency, of age, of density and proportions of the mix, of the nature of the aggregates, of the methods of mixing and placing, and of the manner of curing.

It is shown that in many cases greater compressive strength with lower cost results from other than the usual standard proportions, such as the 1:2:4 mix so commonly used. Concretes differing widely in composition from Fuller's ideal curve were found to give high strength, and conclusive proof was developed to show that the maximum density curve varies for every aggregate and combination of aggregates. The following abstract includes the principal results and important conclusions.

SCOPE AND METHOD OF TESTS

Recognizing that concrete differs from other structural materials in the fact that the actual manufacture must be carried out under conditions varying widely, for example, from the easily standardized and controlled methods in the production of steel, it is claimed that the common procedure used in inspecting the materials and in testing the cement only is no more applicable as a measure of the strength of the resulting concrete than would be an inspection of the ore as an indication of the strength of steel. The importance of basing the selection and proportioning of aggregates upon well-planned preliminary tests, and of extreme care in the practical fabrication of the concrete, are therefore emphasized.

Standard methods of testing were used, and in most cases compressometer readings were taken for the purpose of determining the yield points and coefficients of elasticity. The yield point was found from carefully drawn stress-strain curves, and located at the point where the deformations cease to be directly proportional to the loads. The properties of the aggregates were obtained by making granular analyses, testing for specific gravity, weight per cubic foot, water absorption and percentage of voids. The cement used was generally a mixture of several brands of American Portland cements. Practically all the results given are the average of three or more tests.

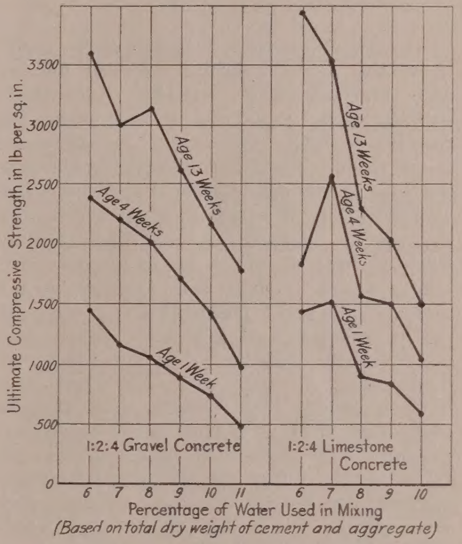


EFFECT OF CONSISTENCY ON STRENGTH OF CONCRETE OF VARIOUS AGGREGATES

Standard 8 x 16-in. cylinders and 6-in. cubes tested in compression

RESULTS OF TESTS

The tests in many respects confirm previous experimental results. For example, the variation of strength with age is indicated by a comprehensive series on mortars and concretes showing decreased strength in long-time tests for neat cement and 1:3 mortars in tension, but increased strength with age for concrete in compression.



EFFECT OF CONSISTENCY ON STRENGTH OF CONCRETE AT VARIOUS AGES

Standard 8 x 16-in. cylinders tested in compression

Results of experiments showing the difference between machine-mixed and hand-mixed concretes, the general superiority of the former and the wide variations (as much as 70 per cent) which may occur due only to the method of mixing the materials, are presented.

An experiment intended to reproduce the conditions met in practice when concrete is placed under water was devised, and the results show that there is a considerable reduction in strength of concrete deposited in this manner, especially for leaner mixtures—the 1:2:4 concrete attained 70 per cent of normal strength, while 1:3:6 concrete at one year showed only 25 per cent of normal. These results are to be considered with caution, because in large masses there would probably be less segregation than in the standard 8-in. cylinders used.

The tests made to indicate the effect of method of storage on strength included specimens stored out of doors after four weeks and specimens stored indoors after one week in a damp room. It is noteworthy that the average strength of 1:2:4 concrete was only 1834 lb. per square inch at the age of one month for the former and only 1176 lb. for the latter. These tests therefore indicate that the commonly prescribed value of 2000 lb. for 1:2:4 mix at one month is excessive, and that the factor of safety of concrete, structures as usually designed and fabricated may be nearer two than four.

The accompanying diagrams indicate the vital influence upon strength of the percentage of water used in mixing concrete. The most satisfactory consistencies from the standpoint of strength and durability are the quaking and mushy mixtures. By "quaking" is meant a stiff mixture upon which water can be brought to the surface by slight tamping and which will not flow readily. By "mushy" is meant a soft mixture which is not watery, but can be spaded and readily worked into place in the forms. Fluid mixtures which flow readily into place in the forms with little or no working, often used for chuted concrete on construction work, will give strength far below that properly obtainable by the same ingredients, owing to the tendency to segregate and the formation of laitance.

Relation Between Density and Strength

Results of another comprehensive series show the direct relation between density and strength—the strength apparently varying directly as the density when the relative quantity of cement to aggregate is the same. The effect of varying the proportions of the aggregates is also indicated. The fallacy in the method of proportioning by voids is pointed out, and many results showing high strength for aggregates differing widely from Fuller's ideal curve are given. The great possibilities of economy in the selection and mixing of aggregates are further confirmed by the series, in which large amounts of coarse aggregates were included. The results show that in every case the addition of large coarse aggregates give higher strength than was attained by the 1:2:4 gravel concrete to which various percentages of large-size trap rock were added. Maximum density and maximum strength are usually obtained with a concrete in which the ratio of fine to coarse aggregate is not less than 1 to 3.

Among the other results of practical significance may be cited the accelerating action of steam pressure, up to 80 lb. per square inch, upon the hardening of mortar, accompanied by increase in compressive strength. Steam-cured mortar or concrete is of much more uniform appearance, and the modulus of elasticity and yield point increase with duration and amount of the steam pressure.

Principal Conclusions

The seventeen conclusions given by the authors, R. J. Wig, G. M. Williams and E. R. Gates, as the result of these tests, are considered so important in affecting standard practice in concrete construction that they are quoted in full:

"1. No standard of compressive strength can be assumed or guaranteed for concrete of any particular proportions made with any aggregate unless all the factors entering into its fabrication are controlled.

"2. A concrete having a desired compressive strength is not necessarily guaranteed by a specification requiring only the use of certain types of materials in stated proportions. Only a fractional part of the desired strength may be obtained unless other factors are controlled.

"3. The compressive strength of a concrete is just as much dependent upon other factors, such as careful workmanship and the use of a proper quantity of water in mixing the concrete, as it is upon the use of the proper quantity of cement.

"4. The compressive strength of concrete may be reduced by the use of an excess of water in mixing to a fractional part of that which it should attain with the same materials. Too much emphasis cannot be placed upon the injurious effect of the use of excessive quantities of water in mixing concrete.

"5. The compressive strength of concrete may be greatly reduced if, after fabrication, it is exposed to the sun and wind or in any relatively dry atmosphere in which it loses its moisture rapidly, even though suitable materials were used and proper methods of fabrication employed.

"6. The relative compressive strength of concretes to be obtained from any given materials can be determined only by an actual test of those materials combined in a concrete.

Relative Value of Aggregates

"7. Contrary to general practice and opinion the relative value of several aggregates to be used in concrete cannot be determined by testing them in mortar mixtures. They must be tested in the combined state with the coarse aggregate.

"8. Contrary to general practice and opinion the relative value of several coarse aggregates to be used in concrete cannot be determined by testing them with a given sand in one arbitrarily selected proportion. They should be tested in such combination with the fine aggregate as will give maximum density, assuming the same ratio of cement to total combined aggregate in all cases.

"9. No type of aggregate such as granite, gravel or limestone can be said to be generally superior to all other types. There are good and poor aggregates of each type.

"10. By proper attention to methods of fabrication and curing, aggregates which appear inferior and may be available at the site of the work may give as high compressive strength in concrete as the best selected materials brought from a distance, when the latter are carelessly or improperly used.

"11. Density is a good measure of the relative compressive strength of several different mixtures of the same aggregates with the same proportion of cement to total aggregate. The mixture having the highest density need not necessarily have the maximum strength, but it will have a relatively high strength.

"12. Two concretes having the same density but composed of different aggregates may have widely different compressive strengths.

Relation Between Gradation of Aggregates and Compressive Strength

"13. There is no definite relation between the gradation of the aggregates and the compressive strength of the concrete which is applicable to any considerable number of different aggregates.

"14. The gradation curve for maximum compressive strength, which is usually the same as for the maximum density, differs for each aggregate.

"15. With the relative volumes of fine and coarse aggregate fixed, the compressive strength of a concrete increases directly, but not in a proportionate ratio, as the cement content. An increase in the ratio of cement to total fine and coarse aggregates when the relative proportions of the latter are not fixed does not necessarily result in an increase of strength, but may give even a lower strength.

"16. The compressive strength of concrete composed of given materials, combined in definite proportions and fabricated and exposed under given conditions, can be determined only by testing the concrete actually prepared and treated in the prescribed manner.

"17. The results included in this paper would indicate that the compressive strength of most concretes, as commercially made, can be increased 25 to 100 per cent or more by employing rigid inspection which will insure proper methods of fabrication of the materials."

Inconsistencies Shown in Water and Sewer Laws

Curious Anomalies Exist in Attitude of Legislatures Relating to the Financing of These Utilities

By W. L. BUTCHER

With Metcalf & Eddy, Consulting Engineers, Boston, Mass.

NOTWITHSTANDING the similarity of the functions of water and sewerage works in contributing to the public health, there have grown up in the different states some rather curious differentiations as regards the laws and the attitude of legislatures relating to the financing of these utilities. There can hardly be any question as to the similarity of the health requirements which demand the installation of both water and sewerage works. The difference appears to be one of degree only, the construction of sewers being delayed, possibly, until public necessity arises, with the police power of the state always in the background, while the construction of waterworks often takes place earlier than sanitary necessity might demand, in order to meet the comfort or convenience of the community.

This latter phase of the matter, with its possibility of profit from the sale of water, early led to the installation of many private plants. The difference in the financial procedures may doubtless be partly attributed to this fact. Their similarity is recognized, moreover, as we find in some communities privately owned sewerage systems being run for profit and in other places waterworks construction financed by "special assessments," although the latter scheme is more particularly associated with sewerage works. Probably the element of compulsion associated with sewers, as distinguished from voluntary participation in the benefits derived from waterworks, has something to do with the differing attitude of the law and legislatures in the two cases.

Liens on Real Estate

One of the anomalies is annually brought to mind in Massachusetts through the effort of the New England Waterworks Association to have bills for water made a lien on real estate. These efforts regularly fail, through the plea of the extra work of conveyancing entailed, in spite of the fact that Brockton and other cities in Massachusetts assess and collect annual bills for rental of sewers, based on the extent of use as measured by the consumption of water. These bills are, in common with all "sewer assessments," a lien on real estate.

Of course, a water department has a lever in that the water may be shut off until the bill is paid, whereas it would be against public policy to shut off a sewer connection. It is quite conceivable, however, that the danger from a lack of water might, under some circumstances, be as serious as a lack of sewerage facilities. As a matter of fact, in New Jersey and possibly other states, water bills are a lien on real estate. In the case cited the differing attitude is further emphasized by the long legal fight ultimately carried to the Supreme Court of the United States, which was necessary before Brockton, Mass., could establish the right to charge annual rentals for sewer connections, based on the extent of use. At the same time, of course, every waterworks in the state was doing this very thing.

PENNSYLVANIA CONDITIONS

Passing now to another state, Pennsylvania, we find still other interpretations of the same points. With regard to waterworks we find rates being charged which are sufficient to pay interest, sinking fund contributions and maintenance expenses, the latter including the cost of renewals of wornout portions of the distribution system, parts of which are originally paid for by special assessments on abutting property. On the other hand, in the case of sewers, the courts have distinctly said that renewals could not be charged to the property benefited. It will be noticed, however, that in the matter of waterworks all charges for sinking funds, renewals, etc., are taken care of through the water rates. Carrying the matter still further, we find that, unlike the case in Massachusetts, communities are expressly prohibited from charging annual rentals or maintenance costs for the use of the sewers. The courts to bring about this condition reasoned through the supposed analogy between pavements and sewers, it being a well-established principle in Pennsylvania that the cost of pavement renewal could not be reassessed on abutting property.

RENEWAL COSTS

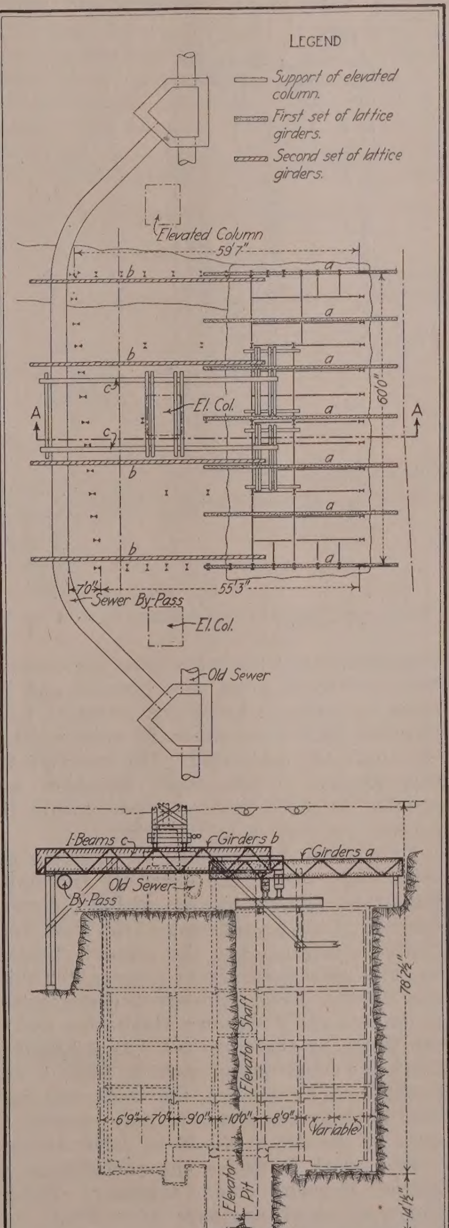
It is, perhaps, easy to see how the different practices relating to the two subjects have grown up. They come partly, of course, from the difference in the functions of the two utilities, although this appears to be a matter of degree only and not sufficient to prohibit absolutely in one case a scheme of financing which is allowed, even if indirectly, in another case. For instance, in those Pennsylvania communities where, in the case of both sewerage and water systems, a portion of the cost is assessed on abutting property, thus assuming them to be analogous to that extent, the possibility of charging any maintenance or renewal costs to abutters is denied in the financing of the sewerage system, but is allowed through the rates in the case of waterworks.

Certainly it would seem, referring to the decisions cited in the foregoing, that the analogy between waterworks and sewers is closer than between pavements and sewers, and whereas it may be inequitable, or at least impossible, to assess any special benefit to abutters, for the maintenance or renewal of pavements, there is no difficulty in at least approximating the extent of special benefit accruing to abutters on account of maintenance and operation of sewers.

New York Subway's Largest Elevator Shaft Sunk Under Forty-Second Street

In Carrying Down Excavation, Rock Was Dropped Into Steinway Tunnel 72 Feet Below the Street and Taken to Shaft at Riverfront

UNDER East Forty-second Street, New York City, at the present eastern end of the Grand Central Terminal of the New York Central Railroad, and about 90 ft. east of Park Avenue, will be located the largest elevator shaft of the rapid-transit subway system of New York City. In the form of a trapezoid, with its east and west lines parallel and 55 and 60 ft. long respectively, the north line approximately the north curb line of Forty-second Street, 60 ft. long, and the south leg 61 ft. in length, with a sectional area of about 3500 sq. ft., this shaft is the largest structure of its kind in the Greater City. To the platform level of the Queensboro subway below there is a depth of about 75 ft., with a maximum depth of 94 ft. in the three elevator pits.



SHAFT AT STAGE WHEN NORTH HALF WAS EXCAVATED, STEEL ERECTED AND STREET LOADS TRANSFERRED TO IT

This shaft will serve as a direct undersurface connection between the New York Central terminal station and the subway lines intersecting at this point, and transfer by means of elevators and shuttle service under Forty-second Street will be made between the west side subway under Broadway and Seventh Avenue, the east side subway under Park and Lexington Avenues and the Queensboro subway under East Forty-second Street. Owing to the fact that the Queensboro subway passengers are now required to walk about 1000 ft. through East Forty-second Street to transfer to the present subway line at Forty-second Street and Vanderbilt Avenue, work on this elevator shaft is being prosecuted with all possible speed to an early completion.

SUPPORT OF STREET

Situated as this shaft is directly beneath East Forty-second Street, with its heavy traffic at all hours, including the cars of two surface trolley lines, and with an elevated railroad structure above it, heavy timbering and strong support of subsurface structures were demanded during excavation. With a decked area about 100 ft. long along the street, and extending from the north curb to the south building line, none of the operations were visible from the surface. For a depth of about 20 ft. the excavation was in earth, which was removed from the southwest through the subway excavation which had been made in the lot adjacent (the site of the old Grand Union Hotel) for a portion of the diagonal station of the Lexington Avenue subway, which was described in the Engineering Record of Aug. 28, 1915, page 255.

Timber sheeting was placed beyond the east and west excavation lines of the shaft and the vault walls of the New York Central Railroad Terminal on the north curb line were shored, the south face of the shaft opening into the adjacent subway excavation. Transverse latticed girders and timber horseheads supported the street-decking system and the substructures mentioned. The gas and water mains and conduits were slung with wire rope from the rangers above and a 4-ft. trunk sewer was bypassed beyond the south lines of the shaft by means of a circular steel pipe, and the old sewer was subsequently removed.

EXCAVATION AND DISPOSAL OF MATERIAL

It had been determined to excavate the north half of the shaft to subgrade first, thus undercutting only half of the street at a time. In the old north and south tubes of the Steinway tunnel, which lie beneath Forty-second Street, heavy timber supports were erected within the lines of the shaft excavation to overcome the effects of heavy "breakouts" or "slips" in the rock immediately above these tubes. Subgrade of the new track floor was approximately 12 ft. below the old Steinway tunnel invert, with a maximum depth in the elevator pit of 24 ft. below. Accordingly, an area 20 x 30 ft. in the northwest section of the shaft was taken down within about 6 ft. of the old Steinway tunnel roof arch and a small opening was holed through to the tunnel below. Up to this point all excavated material was removed through the open subway excavation to the south and from there hoisted to the street level and trucked to scows at the foot of East Forty-second Street. For the section first excavated the rock was uniformly free from breaks or bad seams, although it presented a well-defined dip to the west at an angle of about 30 deg. with the horizontal. This formation was identical with the dip of the rock encountered in the tunnels below. Only a small flow of water manifested itself along the west face of the shaft. For this portion of the shaft timbering was found to be unnecessary.

In the old north tube of the Steinway tunnel a chute was constructed beneath the hole broken through from the excavation above and muck was cast by means of it into cars, which were hauled east a distance of about 2650 ft. by a work trolley running through the north tube to the old Steinway tunnel shaft No. 2 on the north side of Forty-second Street east of First Avenue, and thence by elevator to the surface and by work trucks to scows in the East River. It was possible to dispose of from 12 to 15 yd. of spoil per hour in this manner, against about 8 or 9 yd. by trucking over the surface.

Subsequently, the north half of the shaft cut was lengthened and excavated to subgrade and wall footings and column grillages were set. The steel frame for this area was then erected to the roof level below the street deck, and by posting and blocking up most of the weight of the surface and subsurface structures above this area was tranferred to it. An elevated railroad column south of the excavated area, carrying a maximum load of about 100 tons, was then underpinned by independent girder needles, one end of these needles being supported on a horsehead in the adjacent subway excavation and the other on the permanent shaft structure. Timber posts were wedged between successive floorbeams of the permanent structure down to rock about 80 ft. below, it having been found that the possible total load might be in excess of the strength of the floorbeams and their connections.

The concrete of the exterior shaft walls and all portions of the floor system was then poured. The concrete was mixed at shaft 2 and brought in dump cars to the elevator shaft by work trolley and hoisted in a bucket elevator constructed by the contractor's forces to the several floors, from which the material was wheeled to place.

The south half section of the shaft was then excavated to net lines and subgrade, heavy rope mats and timber buffers protecting the steelwork already in place. Chutes to the previously excavated section carried muck to the work trolley below, and the subsurface-disposal method was continued throughout the operations in this south half of the shaft connecting with the south tube of the reconstructed Steinway tunnel at the southeast corner of Park Avenue and Forty-second Street. Badly shattered and fissured areas on the west, east and south rock faces required two sets of timber at approximately 30 and 43 ft. respectively below the street. These timbers were hung in wire rope slings from deck rangers and braced to the rock walls adjacent and to the north portion of the steel structure in place. Steel pins of 1½-in. diameter and from 10 to 12 in. long were placed at right angles to the dip and also served to hold heavy blocks which were found shattered and seamy. Comparatively little water was encountered here and small flows were panned and led away by pipes, it being the intention later to grout these pipes after the main walls of the shaft are completed. The concrete for this section of the shaft structure was spouted to place from a tower within the subway excavation to the south.

Efforts are being made to complete the steel work, install the elevators and finish the Grand Central Station of the Steinway tunnel and the passageway to the New York Central Terminal and the present subway, so that passengers from Queens Borough may have a direct underground connection to uptown and downtown Manhattan and to the Bronx by the early fall. It is hoped to finish the construction work by Sept. 1, and if this is accomplished, the shaft will have been entirely completed in nine months, in spite of the delay caused by labor strikes.

This work is under the jurisdiction of Alfred Craven, chief engineer; Robert Ridgway, chief engineer of subway construction, and John H. Myers, division engineer, for the Public Service Commission, and is being prosecuted by the Rapid Transit Subway Construction Company, of which George H. Pegram is chief engineer and Robert A. Shailer tunnel engineer.

Cumulative Counterweights Feature Spillway Crest

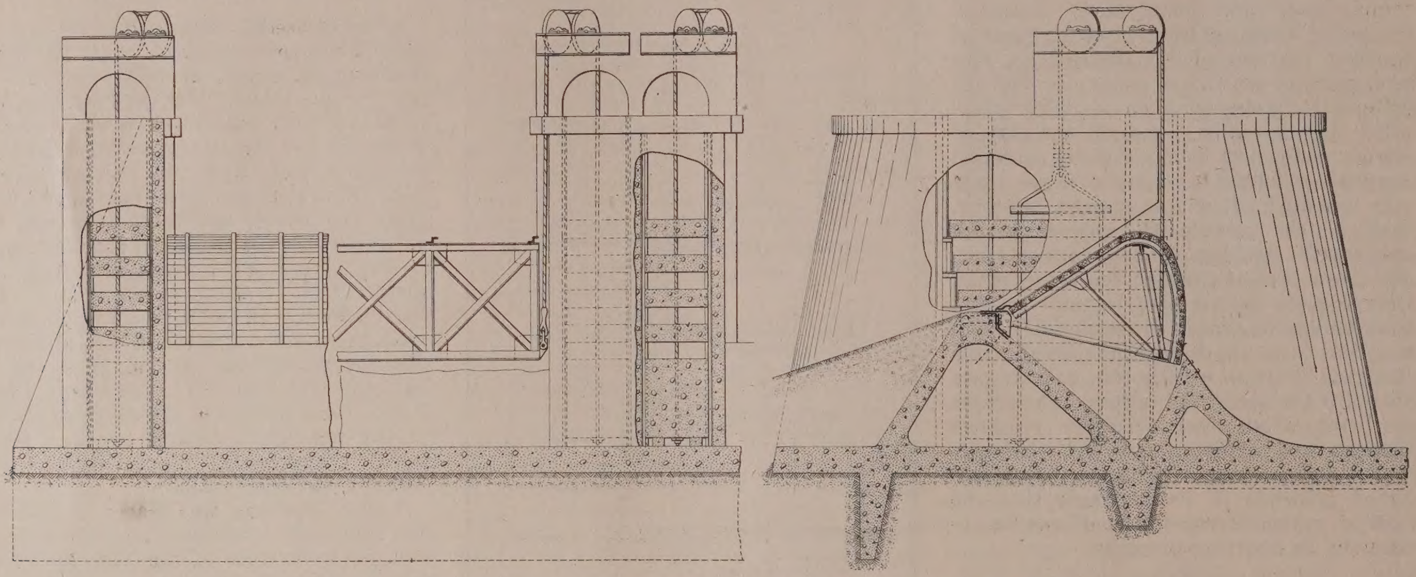
By **JOSEPH WRIGHT**
Engineer, U. S. Reclamation Service

MUCH EFFORT has been expended in devising means for the automatic regulation of reservoirs. The writer has arrived at the design shown in outline by the accompanying drawing. The controlling factor has been an effort at simplicity and reliability, without regard to possible charges of patent infringement.

Several designs for counterweighted gates have been patented, and it is possible that patents may have been issued upon the basic idea, but, be that as it may, since the writer has no thought of applying for a patent, the design is published for what it is worth.

It will readily be seen that the controlling features are a long-span gate, favorable hydraulic conditions and a direct application of an accumulative counterweight.

The first feature is obtained by the introduction of a truss in the gate construction.



DESIGN OF SPILLWAY CREST FOR AUTOMATIC REGULATION OF RESERVOIR WATER

The second is merely a matter of outline. The third is attempted by conveniently locating a series of properly adjusted counterweights, one above the other, inside of hollow piers, to be picked up in their turn as the gate descends.

Simple computations will show that a gate having a lift of 5 or 6 ft. or less may have a length of 50 ft., and even more, and yet be of comparatively light construction. Such a length will permit of the passage of large drift and ice.

The section of crest shown is intended to fit the case of a reservoir having a spillway and chute constructed in earth, the chute descending the sidehill to the stream below.

The counterweighting is intended to be as simple and direct as possible, and certain of operation. Others might prefer a more scientific application of the counterweight, although possibly less certain of action. The counterweights shown may be constructed of cast iron if pier space is valuable. Whether of cast iron or of concrete as shown, they should contain hollow spaces to be loaded with pig iron to obtain a perfect adjustment after trial. In the case under consideration, both the piers and the gate recess may be readily drained—the latter enough to obviate back pressure.

Columns in First Floor of Boston Theater Avoided by Use of 106-Foot Truss

Special Balcony Framing of Diagonal Girders and Cantilever Trusses Involves Complex Detailing for Field Connections

TO COMPLY with the owner's requirement that no columns whatever should be allowed to obstruct the view from the seats on the first floor of the recently completed Loew's Orpheum Theater in Boston, an unusual structural-steel framework of trusses and girders was designed to carry the balcony loads to the outside wall columns.

A main truss of the subdivided panel type spans the distance of 106 ft. between columns. Parallel to this a 53-ft. front truss supported by two diagonal double girders acts as a fulcrum for the cantilever trusses. The diagonal girders rest upon wall columns at one end and upon the main trusses near the center at the other. Clearance requirements which limited depths and door clearances necessary to permit passageways from mezzanine floor to balcony made the main-truss outline unusual and the details of design exceptionally difficult.

In addition to, and closely related with, the limitations in the design of the main members were the complexity of the field connections and the necessity for devising practicable details. At one point three main members intersect—a diagonal double girder, the front or fulcrum truss and a cantilever truss. The details of the connection here adopted are shown in drawings of the various members; the front truss is framed into the cantilever and the latter rests upon the diagonal girder, with its lower chord passing through slotted holes in the web plates of the double girders.

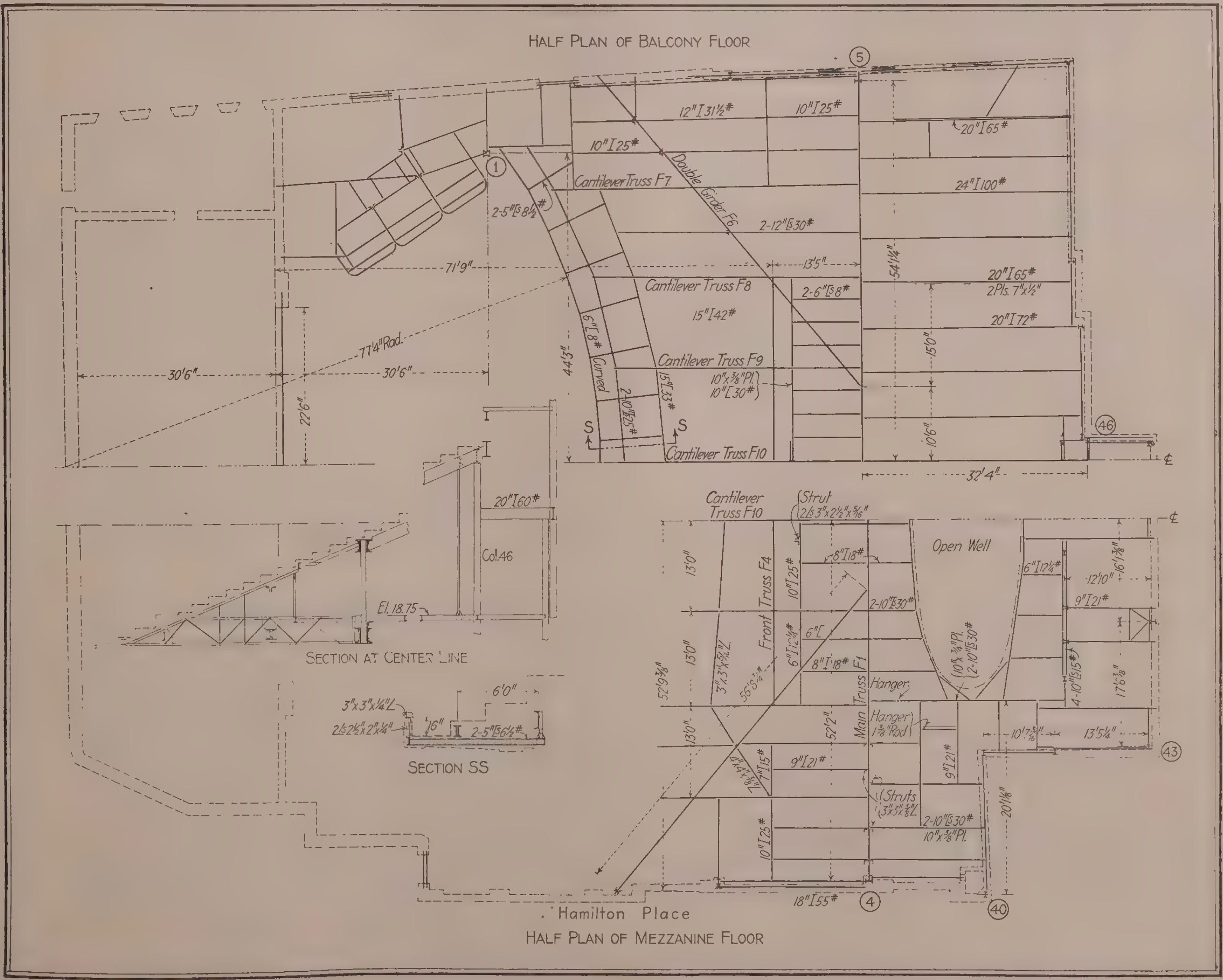
General Plan of Framing

As indicated in the accompanying half-plan and sectional views of the framing for the balcony and mezzanine floor, the building is of unsymmetrical outline, situated on a lot about 158 x 108 ft. on Hamilton Place. It has a seating capacity of 3000. The main 106-ft. truss F1 is supported by built-up box columns of two 15-in. channels with 18-in. cover plates. Most other columns are 8-in. and 10-in. Bethlehem H-sections. The fulcrum truss F4 is 13½ ft. from the main truss, and is supported by the diagonal girders F6 nearly 60 ft. long, which rest upon the main truss at points 10½ ft. from the center.

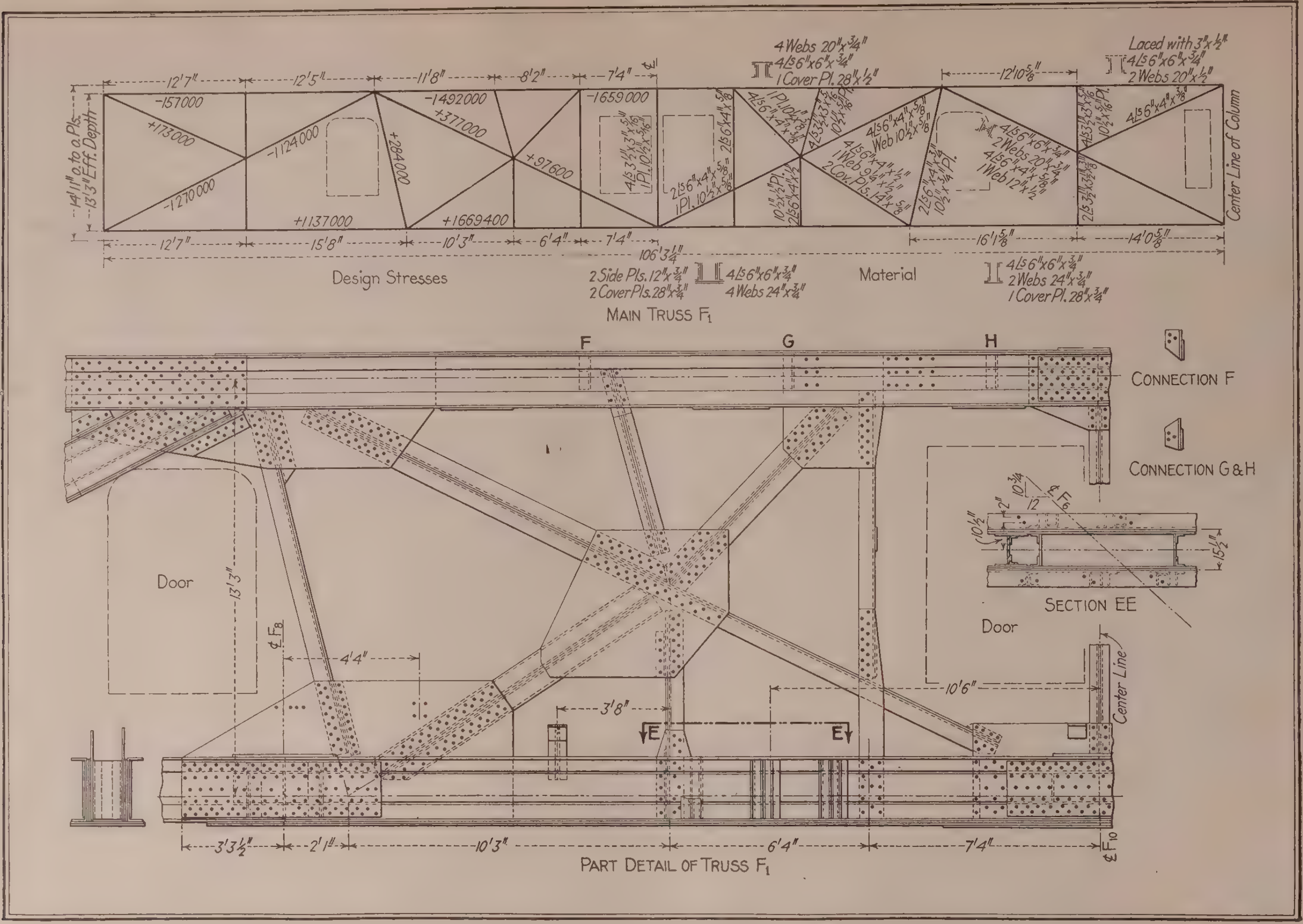
Steel I-beam framing of the usual type supporting reinforced-concrete stepped construction for the balcony is indicated on the sections and plant, designed to conform to a parabolic outline. Curved-face channels for the balcony are carried by projecting cantilever beams of 6-in. channels about 9 ft. long, staggering with the cantilever trusses, the rear uplift being resisted by 15-in. channels. The open well in the mezzanine floor made it necessary to design some of the steel beams in that floor as cantilevers from the front truss or the diagonal girders over the lower chord of the main truss. In some cases rod hangers supported similar beams. Longitudinal beams between the cantilever trusses, in addition to acting as mezzanine floor framing, carry two-angle vertical struts that support the upper chord of the cantilever trusses by longitudinal channels, to which the intermediate sloping diagonal beams are connected.

Main Truss Details

The overhead clearance lines for the lower floor and the necessity for keeping below the known sloping seat lines fixed by the requirements for clear sight lines to the stage limited the depth of the main trusses to 14 ft. 11 in. out to out, as noted on the stress sheet in one of the drawings. The irregular panel lengths were necessitated by



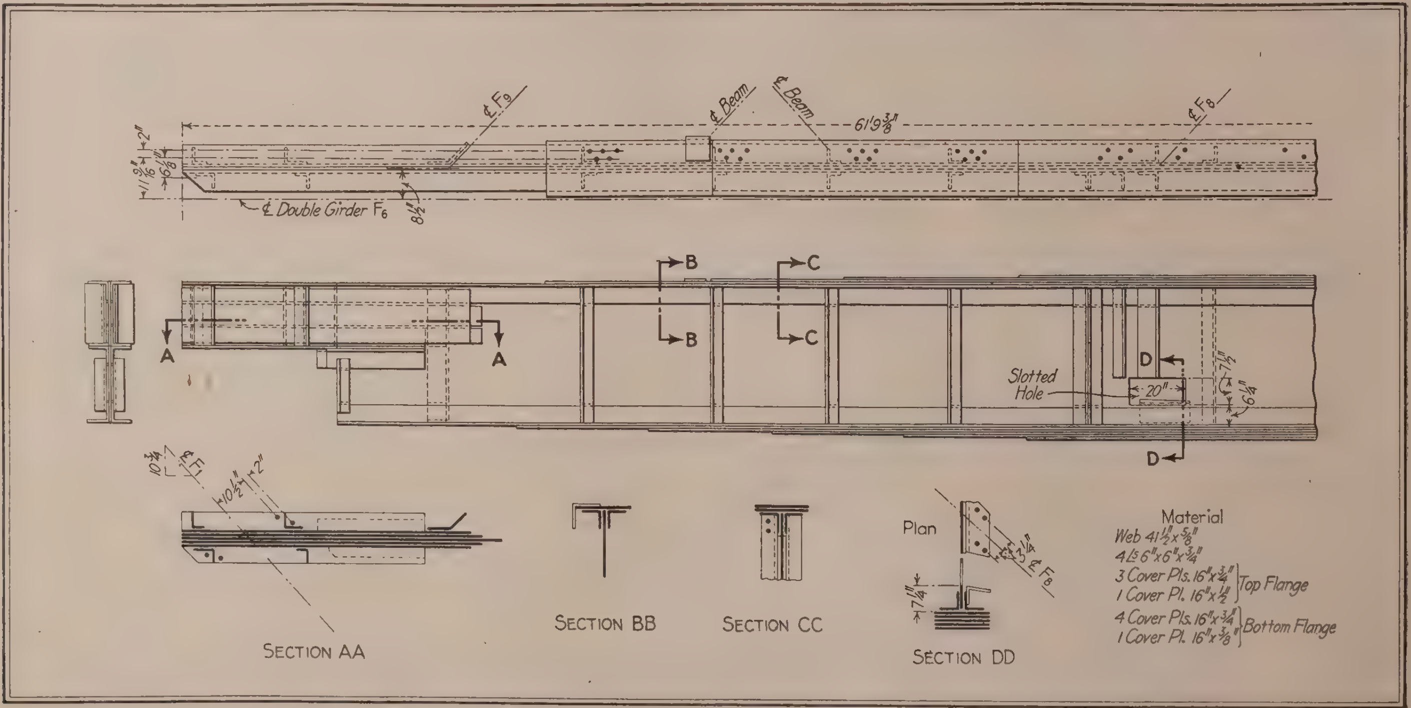
HALF-MEZZANINE AND HALF-BALCONY FLOOR PLANS WITH SECTION AT CENTER SHOW GENERAL LAYOUT



CENTRAL PANELS OF MAIN TRUSS F1 CONTAIN UNUSUAL DETAILS AND SPECIAL CONNECTIONS—STRESS SHEET ABOVE

the openings for doors to accommodate inclined passageways from the mezzanine floor to the balcony as well as the requirement for bearing surfaces on the lower chords at the points where the diagonal girders are carried. As shown on the detail drawings, these girders F6 do not connect to the truss F1 at panel points, but are cut back to pass across the lower chords and rest upon them. The chords are therefore designed for both direct and bending stresses, using typical built-up half-box sections.

The specified live load for all floors was 125 lb. per square foot, with 200 lb. for the stage, 100 lb. for the dressing rooms and 40 lb. for the roof. The heavy sections and high stresses for the main truss are noteworthy, as are also the subdiagonal systems and the large gusset plates. The top chord carries the sloping beams, the connections for which are provided as indi-



PART ELEVATION OF ONE GIRDER F6, SHOWING SPECIAL CONNECTIONS FOR BEAMS AND TRUSSES

FORWARD ENDS OF CANTILEVER TRUSSES AND PROJECTING BEAM FRAMEWORK

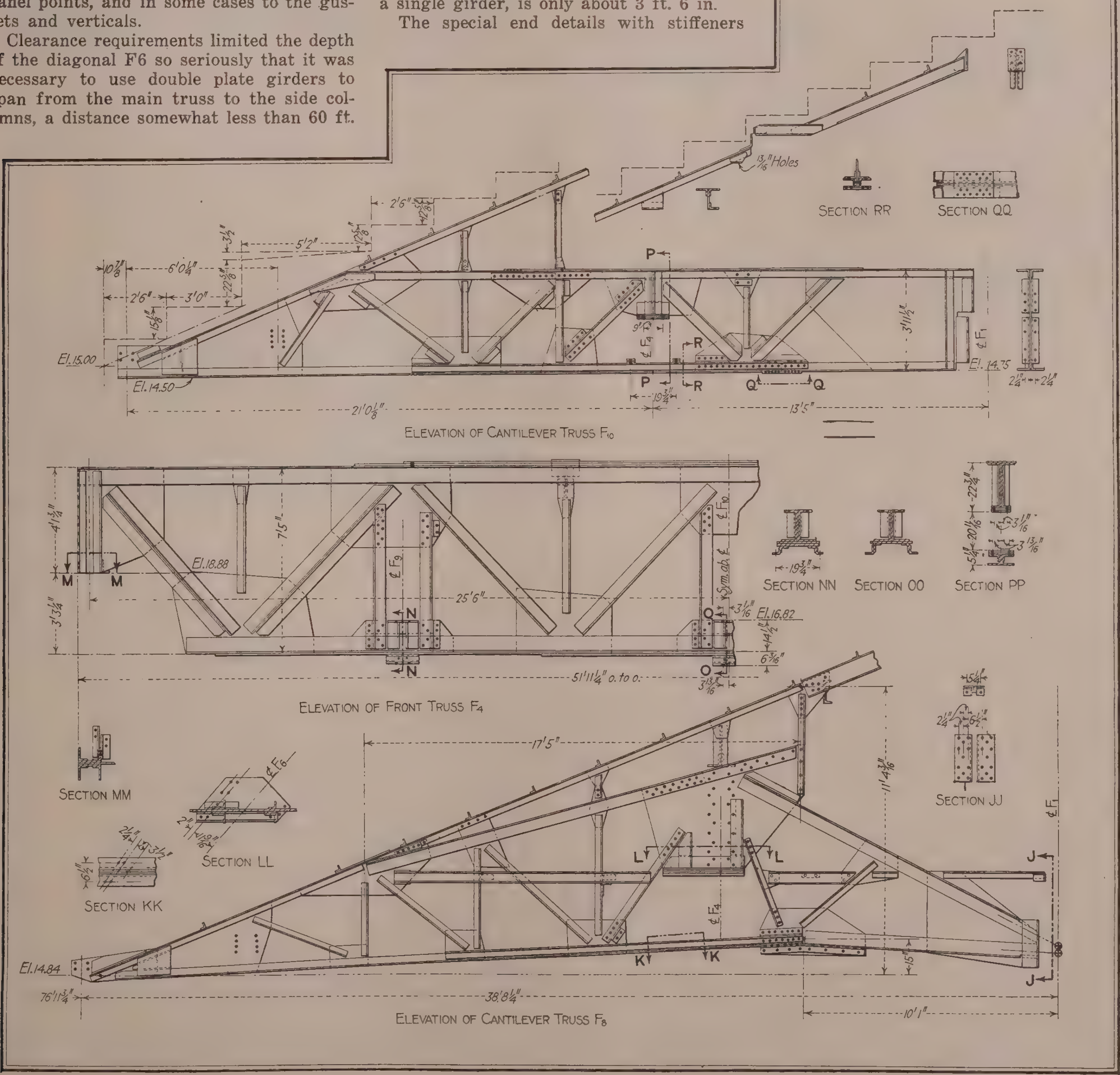
cated by part sectional views. The cantilever trusses connect to the lower chord at panel points, and in some cases to the gussets and verticals.

Clearance requirements limited the depth of the diagonal F6 so seriously that it was necessary to use double plate girders to span from the main truss to the side columns, a distance somewhat less than 60 ft. The depth back to back of angles, as noted in an accompanying drawing of one end of a single girder, is only about 3 ft. 6 in.

The special end details with stiffeners and reinforcement of the web plate where the girder is cut back to pass diagonally over the lower chord of the main truss F1 are indicated in the drawing. The end stiffeners were turned in opposite directions to give better bearing on the main sections of the chord. Clip angles and punched holes in intermediate stiffeners are provided, as indicated, to carry the mezzanine-floor framing beams at the top flange.

To support the fulcrum truss which frames into the cantilever truss F8, the latter rests upon the top of these diagonal girders, and is so framed that its lower chord passes through a slot shown in the webs of the double girders, with connections to shelf angles as indicated in the sectional view.

One of the drawings showing the front or fulcrum truss F4, a triangular truss about 7½ ft. deep, and the cantilever trusses F8 and F10 indicates the nature of the con-



TYPICAL TRUSSES F4, F8 AND F10 INDICATE CONNECTIONS BETWEEN CANTILEVER TRUSSES AND FRONT TRUSS nections. The fulcrum truss F4 contains double verticals spread sufficiently to permit the cantilever trusses to pass between them over the lower chord and rest upon it by seats to the top chord at their panel points. The end connection of this truss F4 to the cantilever F8 by ordinary end angles framing into a large gusset plate is indicated, together with the large bearing plates of this cantilever F8 upon the top of the diagonal double girder.

The cantilever truss F8 is a typical example of the complicated framing required to provide practicable details at the connections. The location of field splices, indicated by the field holes at the joints, was a matter requiring special consideration in order to frame the various parts in proper order. The broken alignment of the lower chord passing through the diagonal girder webs was necessary in order to avoid interference with the lower flange angles of these double girders.

On the top chords of the cantilever trusses supporting the reinforced-concrete stepped floor of the balcony, clip angles are provided just below the risers to increase the bond. These upper chords must resist both direct and bending stresses; they are designed of unequal-legged angles, detailed with the short legs vertical.

The two main roof trusses, one of 106-ft. span, had chords of Bethlehem H-column sections. These sections were found to be both economical and efficient and permitted simple and practical details of connections and splices.

The grid-iron construction consisted of 2 x 3/8-in. flats, 4 in. on centers, placed with the 2-in. dimension horizontal, battened together on about 2-ft. centers and resting on a 4-in. 5¼-lb. H-spaced about 4 ft. apart, thus forming a removable grating, spanning longitudinally over the stage. This design of gridiron has been installed in a number of New York theaters and found to be very satisfactory, and is generally considered to be preferable to the 3-in. channel construction used extensively in Chicago and the West, which spans transversely over the stage. It is considerably more economical.

The general contractors were the Fleischman Construction Company, of New York City. The steel frame was designed and fabricated by the New England Structural Company of Everett, Mass., of which W. B. Douglass is president; E. N. Pike, chief engineer, and C. L. Downie, chief draftsman, subject to the approval of Hector R. Burroughs, of New York City, consulting engineer. Thomas W. Lamb, of New York City, and the Hoffman Company, of Philadelphia, were the architects.

Solids a Problem at Power Plants in Northwest

Gravel, Sand and Silt in Streams Originating in Glaciers Must Be Handled Effectively to Obtain Satisfactory Results

By JOHN HARISBERGER
Superintendent of Water Power, Puget Sound Traction, Light & Power Company, Seattle

STREAMS that originate in glaciers in the mountains generally have a heavy fall and carry a large amount of solid matter, which consists mostly of sand, gravel and silt. This is particularly true during high-water periods in the upper parts of streams rising in the Cascade and Olympic mountains. In the design and construction of waterways and reservoirs for the utilization of water from these streams, careful attention must be given to methods of handling this solid matter effectively if satisfactory results are to be obtained. Gravel is the easiest to get rid of, as it settles readily, unless the velocity of the water is very high. It can generally be taken care of by properly constructed rock spillways in the supply canal. As the sand settles much slower, one or more settling basins are necessary, while silt, which has the characteristics of volcanic ash, will stay in suspension for several weeks even in perfectly still water.

Disposing of Gravel in Supply Canal

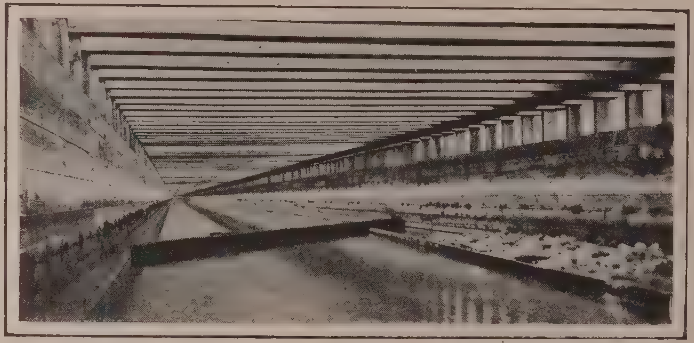
Usually the reservoir formed by a diversion dam across the stream, unless sluiced or dredged out frequently, does not have much value as pondage for any great length of time, as it acts as a settling basin and will soon fill up with gravel and sand on account of the decreased velocity of the entering water.

A smooth channel cut several feet below the intake, at right angles to it and in the direction of the river flow, will prevent a great deal of gravel from getting into the intake. This channel should be so constructed that the velocity of the water will be quite high during floods, when much gravel is moved, and it should be carried by the intake and through the dam. A certain amount of gravel is bound to enter the supply canal, which can be disposed of by means of a rock spillway. The latter generally consists of a diverting wall 2 or 3 ft. high, built diagonally across the bottom of the canal, and an opening through the side of the canal to discharge the gravel diverted. It is desirable that the canal up to the rock spillway be of rectangular cross-section and lined with wood, concrete or iron. The velocity of the water should be high enough to keep the gravel moving.

GRAVEL IS WASTED THROUGH AN OPENING IN CANAL BANK

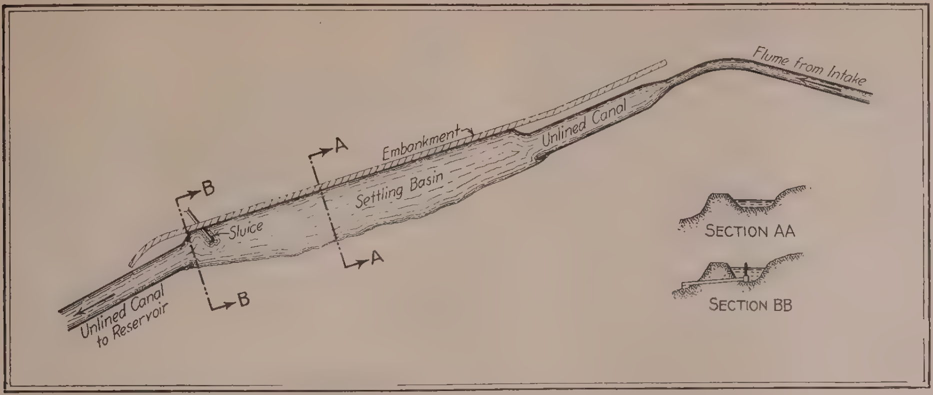
PILE OF SILT DISCHARGED THROUGH SMALL LEAK IN FLUME

The sand should be allowed to settle before the water enters an unlined canal in earth, as the low velocity that is made necessary will allow the sand to settle. Where lined canals are used, it is the practice to utilize sandboxes and sluiceways to remove a certain amount of the sand, but unless these are quite large and the sluiceways are kept open at all times, which wastes a great deal of water, they are not very effective. As the velocity in lined canals is generally kept fairly high, most of the sand does not get a chance to settle, although the amount that will get through a small leak is surprising.


DIAGONAL DIVERTING WALL INTERCEPTS GRAVEL

As silt stays in suspension for several weeks, it is the most difficult material to get rid of. Fortunately, it does the least amount of damage to waterwheels, pumps, etc., in the way of erosion, but it seriously affects the operation of water-pressure governors and causes rapid scaling in the water-cooling coils for transformers and bearings.

The following seems the best solution of the problem of removing the sand and the heavier silt. There is no method of eliminating the lighter silt carried in these streams, to the writer's knowledge, unless

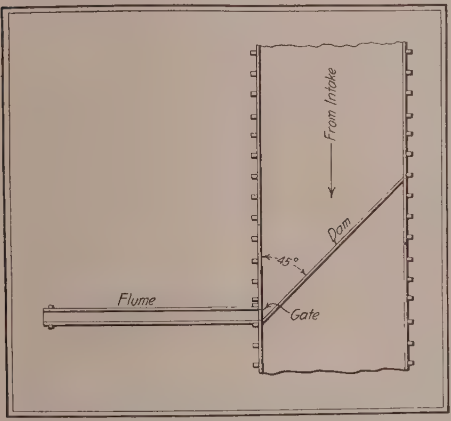


SAND IS DROPPED IN SETTLING BASIN—SLUICE PROVIDES MEANS OF CLEANING

the water could be impounded for several weeks before using.

Location of Basins Important

The location and design of the settling basins should be given careful attention. The regulating reservoirs to which the penstocks connect should not be used as settling basins if it can be avoided, at least not for sand. The best arrangement is to have the rock spillways and settling basins near the intake. The size of the basins will be determined by the amount of water to be handled and the quantity of sediment carried therein. The basins should be of such size that it will not be necessary to clean them out oftener than once a year, also that the movement of the water will be slow enough so that all sediment but the light silt will settle and not be carried to the canal leading to the regulating reservoir.



DAM AND FLUME CONSTITUTE ROCK SPILLWAY

In the construction of the basins provision should be made so that they can readily be drained and cleaned out. It may be necessary to lay a pipe line around them and to arrange that water under pressure will be available for sluicing to facilitate rapid removal of sediment. Provision must be made to carry the water from the intake around the settling basin while the basin is being cleaned, to avoid interruption to the service for which the water is used.

The cleaning out of the basins should be done at a time of the year when the water does not carry any sediment. In the locations under consideration the most sediment is carried during the heavy rains, which generally occur about November and March, and during June, July, August and September, when the water from the melting glaciers brings down a large amount of sand and silt.

In this discussion it is assumed that the conditions are such that all the flood water of the stream cannot be impounded and utilized, so that the loss of water in rock spillways and in the cleaning out of the settling basins would be of little value. In case the settling basins are so constructed that they cannot be readily drained, or can be drained only through the penstocks, the only solution for cleaning is the use of a dredge, and a suction dredge will be most suitable, as sand and silt are the materials to be handled. A small suction dredge with a capacity of about 5 sec.-ft. will handle from 6 to 10 per cent of solid matter in the way of sand and silt.

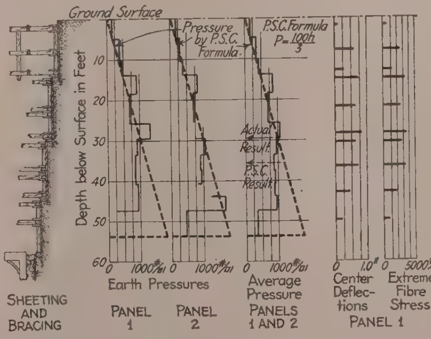
Test Earth Pressures in Subway Excavation

Deflection Measurements on Timber Rangers and Computed Values of Pressures Up to 50-Foot Depths Reported

Measurements of the deflections of timber rangers in the subway excavation work at Flatbush Avenue, Brooklyn, indicate that the actual earth pressure follows roughly or somewhat exceeds the values given by the Public Service Commission formula for earth pressure for the first 30 ft. below the surface, while below that depth the pressures do not increase in accordance with that formula. These results and conclusions are given by Max Miller, junior engineer, in the *Public Service Record*. A short abstract of the methods used, with a diagram indicating the results, is presented herewith.

Method of Testing

Deflections were measured for every ranger employed in retaining a bank over an area 22 ft. horizontally and 55 ft. vertically. The excavation at this point is approximately 85 ft. wide and 80 ft. deep in a soil of glacial formation consisting of coarse sand intermixed with 20 to 30 per cent of clay and some gravel, with occasional large boulders. The excavation was started seventeen months previous to the observations.



MEASURED DEFLECTIONS—COMPUTED PRESSURES AND FIBER STRESSES

As indicated by the accompanying diagram, the 3 x 10-in. vertical sheeting was supported by longitudinal rangers varying from 10 x 10 in. to 12 x 12 in., held every 10 ft. by transverse needles extending continuously across the entire width of the cut.

The deflections were measured from a fine string stretched parallel to the beam to five different points along the inside face of the rangers, the difference between the offsets denoting the relative deflection of the points. The soil-pressure intensity required to produce the given center deflection was computed.

Computed Results

The diagram herewith indicates the resulting computed pressures at the various depths down to 50 ft. for the two panels tested, in addition to the center deflections and the maximum fiber stresses. It is evident that for the first 30 ft. down the pressure increases with the depth to a maximum of about 800 lb. per square foot. Below this and up to a depth of 45 ft. the pressure is practically constant at 900 lb., and the next 10 ft. shows a reduction of pressure. The comparison between actual pressures as computed from the deflections and the pressures by the Public Service Commission formula ($100h/3$) is clearly indicated on the diagrams. The total actual pressure per linear foot is 36,000 lb., which is 75 per cent of the value by formula, and the resultant is about 6 ft. higher, giving an overturning moment about equal to that computed by formula.

Europe May Need Our Lumber

The forests of Belgium and those in northern France on both sides of the fighting front have sustained severe damage from artillery and small-arms fire, according to P. S. Ridsdale, editor of *American Forestry*. Probably greater destruction has resulted, not only in these countries but also in England, from extensive cutting of the timber for engineering construction at the front. It is thought that most of the forests in the British Isles will have vanished by the end of the war, as a result of the imperative need for timber, coupled with prohibitive ocean freight rates and lack of vessels for importing. Little is known of the condition of the Italian and Austrian forests, while those of Russia are so extensive and dense that the ravages of war can hardly have made much impression on them. It is certain, however, that Germany has cut a great deal of timber in occupied enemy territory, especially in Poland and western Russia, as, having that source of supply, it is likely that this nation, with its customary thrift, has kept its own forests intact. An extensive investigation of the lumber situation in Europe has been planned by the Federal Government to aid American producers. A meeting to determine the lines along which the investigation will proceed was held Aug. 21 in Chicago between the representatives of the lumber industry and officials of the Bureau of Foreign and Domestic Commerce, the Federal Trade Commission and the Forest Service.

How Location Affects Track Maintenance

Numerous Difficulties for the Section Gang Are Due to Poor Choice of Site—Higher First Cost May Mean Much Lower Upkeep

By KENNETH L. VAN AUKEN
Chicago, Illinois

THE SUBJECT of gradient, curvature and the like has been fully discussed as it affects the operation of heavy trains over a railroad line, and this subject has recently been given a great deal of attention. The effect of location on the cost of maintenance, however, is a subject but little touched on. The methods of construction and the standards of construction also have a great effect on the cost of maintenance.

The maintenance of track is materially affected by (1) character of soil in cuts and embankments, (2) character of earth beneath embankments, (3) percentage and degrees of curvature, (4) proportion of sidehill cuts, (5) amount of location along river banks, (6) height of embankments, (7) number of tunnels, bridges or trestles, (8) amount of embankment which obstructs old watercourses, (9) gradient in cuts, (10) curvature in cuts, (11) width of cuts, (12) percentage of embankment in countries subject to deep snows, and (13) number and length of reverse and compound curves.

CHARACTER OF SOIL

It is extremely difficult to keep track maintained to a high standard in wet, soft cuts, or even to keep such track comparatively safe. The mud or clay from the subgrade works up between the ties, the ballast in the meantime working down into the subgrade so far that it becomes of no use in supporting the track. About the only remedy for a condition of this kind is a tile drain placed deep enough so that the water will be drained out to the bottom of the ballast.

The clay or mud from wet cuts makes very poor material for an embankment. Not only is a much larger yardage required, because the material will spread out much further, but even after being built, the embankment is unstable and serious slides are likely to develop in rainy weather. Track is likely to heave badly in winter on such a fill, unless precautions are taken early to remedy the drainage.

CHARACTER OF SUBSOIL

It is often necessary, or thought advisable by the locator, to run a line through a very soft marsh. There have been places of this kind where a timber float had to be built under the track in order to hold it up, and still other places where a trestle had to be built finally, after many thousand yards had been dumped and disappeared. There is likely to be an upheaval of earth at some near-by point, and occasionally this dams up a stream. A lake will then form and is likely to result in damage suits from land owners.

There have been places where the line was located over a low piece of ground which seemed to be dry but later proved to be simply a thin crust over an underground lake. Usually the conditions are not discovered until after the track has been laid and part of the fill made, and then there is likely to be a sudden giving away of the whole embankment. This defect makes its appearance usually before the track is turned over to the maintenance department.

Rail creeping is serious on a fill with a soft bottom. Rail creeping is caused in part by the deflection of the rails under load, and the softer the bottom the greater the deflection will be. Also, the subgrade and ties are likely to be saturated in a marsh; the ties naturally rot sooner and the rails and fastenings corrode more quickly.

CURVATURE

Curves are much harder to maintain than tangents, on account of the tendency of the rails to spread and let the gage widen. Of equal or greater import, however, is the tendency of a curve to get out of surface. This is caused by uneven balancing of the slow and fast tonnage, so that one rail gets a greater proportion of the weight of trains than the other. It is usually necessary to elevate the curve high enough for the fast trains, which makes the elevation too great for the freight trains. In such cases if the freight traffic is heavier than the passenger traffic (and usually it is) the low rail will receive a greater proportion of the total loads than will the high rail, and tend to become still lower, thus increasing the elevation and necessitating resurfacing.

Rail wear on curves, especially on those where the curvature is high, is very severe, many cases being instanced where rails last only a tenth as long as they do on tangents. On account of constant regaging of the track, the ties on a curve are likely to be spike-killed and their lives greatly shortened. Because of the fact that all the materials wear much more quickly, inspection must be made more frequently and more carefully on a curve.

It is usually necessary to line the points of curves much more often than any other part of the track, and it is almost impossible to maintain a uniform curvature unless center stakes are correctly maintained all the way around. This is almost impossible. When a foreman lines his curves by eye, while they appear to the naked eye to be smooth they are really composed of a series of compound curves, and the effect on fast trains is easily felt. These are reasons why, from the maintenance point of view alone, curvature should be reduced to a minimum, except in cases where the gradient may be reduced materially by increasing the amount of curvature.

SIDEHILL CUTS

If sidehill cuts and embankments are not made correctly the embankment part will cause trouble by sliding, because it does not attach itself to the hill. In order to make a good non-sliding joint, the sidehill should be cut off in a series of steps before the earth for the embankment is deposited. Even then the outside of the fill will settle much faster than the inside, so that such track is difficult to maintain, particularly for the first five or six years after being built. Furthermore, frost in winter has a better chance of getting under one side of the track than it does of the other, and this causes difficulty with uneven heaving. The frost will go out much more quickly from the outside of a sidehill cut, and is likely to leave the track rough in the spring when the heaved track is thawing out and settling back.

Where there is a long slope above a sidehill a large amount of water will flow toward the track during heavy storms. This will necessitate surface ditches of very large capacity, if the track is to be entirely protected from overflow water. Where the slope is nearly at right angles to the track or the surface ditches, they are much more likely to overflow, and they will fill with sediment much more quickly than surface ditches in other places.

LOCATION ALONG RIVER BANKS

An embankment built along the bank of a river must usually be riprapped to prevent washing. Even then there is danger from excessive high water, which in some localities covers the track and starts undermining the ballast, thus eating the bank out from the inside. Whenever the water gets into an embankment it begins to soften the foundation, and is thus likely to cause trouble even if the water does not get high enough to wash away the embankment. Track in such location requires more inspection during the spring, or during periods of high water, than other track does.

If embankments are made too low in the vicinity of streams, even where ordinarily there is very little water flowing, they are sometimes overflowed in the spring when there is an immense extra quantity of water from melting snow and ice. Ice often dams up streams where the channel is obstructed, thus causing the water to rise very rapidly. While there is not as much danger of the track being washed out when the ground is frozen hard as at other times, these floods temporarily tie up traffic and occasionally leave the track covered with large chunks of ice, which require hours to remove. As the water recedes it leaves the sags last, one sag sometimes holding up traffic on an entire division for several hours.

TUNNELS AND BRIDGES

It is difficult for a track foreman to keep track in line on an ordinary bridge, and even more difficult on a pile bridge. Usually the track is put in fair line when the rails are first laid, but, due to uneven settlement, the line soon becomes imperfect. And frequently the foreman puts off the work of correcting this because he knows he will spoil his ties by too frequent spiking, because he expects the bridge to settle still more, so that his line will be spoiled even if corrected, and because it is difficult to do work on a bridge. On trestles where no refuge platforms are provided, a great deal of time may be lost in getting off for trains.

It is difficult to handle tie renewals on a bridge, and rail renewals are not as easily handled as on the regular roadbed. Furthermore the work of distributing ties or rails on the bridge is more dangerous and more likely to result in accidents.

Tunnels are even more difficult to maintain than bridges. In some tunnels it is dangerous for the section crew to remain in the tunnel as the train goes through, on account of the suffocating gases. The time available between trains is partly wasted by the men walking to and from the point of work. There is very little room to work in tunnels, and there is great danger in operating section or motor cars through them unless they are operated on train orders. The conditions in a tunnel favor the rapid corrosion of rails and the rapid rotting of the ties, so that the maintenance cost of renewals is also excessive.

Frequently it is found advisable to change the course of the stream in order to cut down the number of bridge crossings. While this apparently shows a saving in construction, frequently the trouble experienced later in trying to keep the river in the new channel entirely overbalances the saving made originally.

Furthermore, there is always the danger of a rapid change in the course of a river which will throw the current strongly against an embankment which, when it was built, was entirely out of the way of the stream at ordinary height of water. Some streams are particularly noted for this kind of behavior, among these being the Missouri River.

GRADIENT AND CURVATURE IN CUTS

A curvature should not be located on a level gradient if possible to avoid it. A cut should preferably have a summit at the center, with descending grades each side, to provide for drainage; if this is impossible it should be located on an ascending or descending gradient. It is almost impossible to get good drainage in a long, level cut. The ditch has to be made very shallow at the middle of the cut and all the slope put in the bottom of the ditch. This does not usually give enough slope, and it is likely to leave the ditch too shallow at the middle of the cut to protect the track, so that trouble is likely to be experienced with soft spots at such places.

Curves in cuts make it very difficult for the engineman or the maintenance crews to see the track ahead, and therefore are a prolific source of accident. Reverse curves in a cut are especially bad. They require more work to maintain and are much harder to drain than a straight cut. Usually a section with many such curves must have extra section men because there is almost a constant necessity for a flagman to protect the section crew in its regular work.

NARROW CUTS

Cuts made too narrow at the base, or with slopes too steep, are expensive to maintain. The ditches fill up quickly, thus stopping the drainage and causing trouble with water pockets in summer and with ice and heaved track in winter. Without drainage there can be no solid foundation, therefore cuts should be made wide enough so that the work of ditching will not consist of widening the cut, but merely of clearing out the débris from the ditches.

The cost of widening a ditch by hand labor is high. A ditcher can be used, but it is always more economical to take the material out before traffic has been turned on the line and when work trains can be operated without interfering with regular traffic.

In northern countries the greater the percentage of embankment the less the trouble with snow.

Not only are reverse curves hard to maintain, but they are not safe for high-speed traffic, because there is no chance to run out and run in the elevation between them. Where there are two simple curves close together it is better policy to make one compound curve of them, because, if the elevation has to be run out and then run right back in again, it not only makes poorer riding track but makes maintenance more costly. Further, a short tangent between two curves always appears to have a swing in it.

This discussion may sound more or less theoretical, as it is not always possible to make a choice which will eliminate bad maintenance conditions. There are almost always, however, two or more preliminary lines considered before the final location is made, and the engineer should take the maintenance conditions on the several lines into consideration when making his choice. Frequently the choice is between a low line located in a valley between a range of hills, or one on top of the range. As far as maintenance is concerned the top-of-the-range site is usually the better one.

It is often possible to select the material which shall be used in embankments, by hauling a little farther or using side borrow and wasting poor material from clay hills. One mistake that is sometimes made is to put in an extra amount of curvature in order to save some yardage in the original location. This may make a cheaper first cost, but certainly does not make a cheaper ultimate cost. Sidehill cuts, by the shifting of the line and the increasing of the amount of excavation, can frequently be cut far enough into the hill to eliminate most of the bad features.

There are places in location where one curve can be made to do the work of two by increasing the yardage. This is also true of many of the other conditions mentioned in this article; and if the extra cost of maintenance is figured, a location requiring increased yardage will often be found ultimately profitable.

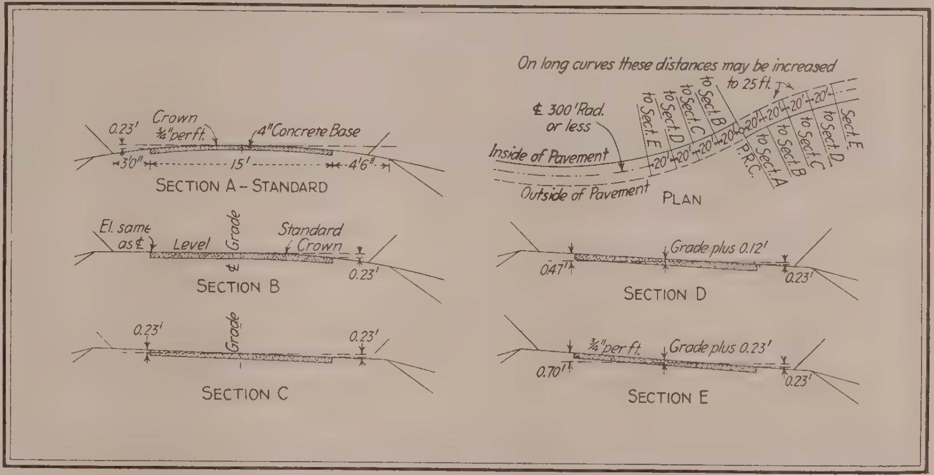
Superelevation Determined for Highway Curves

Formula, Giving Relation of Radius, Grade and Length of Arc to Proper Superelevation, Used by California Commission

THE California Highway Commission has announced as its policy on the superelevation of pavements that only such conditions as would make ordinary motor travel dangerous are to be eliminated. It is not considered necessary to go into great refinement in laying out superelevation, but rather to strike a happy medium between the theoretically exact analysis or a neglect of the subject, and so to provide superelevation only where actually required as a safeguard against accident.

It has been noted that if crowned sections are used on short radius curves of considerable length, the driver of a motor vehicle traveling at a fair speed is tempted to keep to the inside of the curve, although he may thus have to travel on the left side of the road. This is due to the desire to take advantage of the crown of the road as a superelevation. This tendency becomes almost a necessity in wet weather, particularly with small speed motor trucks loaded so that the center of gravity is high.

In determining what superelevation is advisable, in view of the foregoing, three elements of the layout are given consideration—namely, degree of curvature, grade and length of curve. The controlling factor, however, is the degree of curve. In other words, it is really unnecessary to superelevate the large-radius easy curve where the speed of vehicles is limited by law to 20 or even 30 miles per hour, inasmuch as the average driver almost invariably reduces the speed on curves, particularly where the view ahead is obstructed. It is therefore the sharp curve, introducing considerable centrifugal throw, which is considered as warranting particular attention as to superelevation.



TRANSITION FROM CROWNED TO SUPERELEVATED SECTION ON REVERSE CURVE

For a given width of pavement established as suitable for the volume of traffic involved certain proper speeds on specific radius curves can be assumed, the commission believes, and the following relation, based on the unit amount of superelevation necessary to eliminate the outward throw, can be used to determine the unknown:

$$V = \sqrt{\frac{32.2 \times R \times e}{w}}$$

in which R equals radius of curve in feet, e equals superelevation in feet, w equals width of roadway in feet, and V equals velocity in miles per hour. It might be noted that considerably higher speeds than the theoretical ones given in the table are safe and comfortable for passenger machines on account of the margin against overturning inherent in their construction. The formula gives speed at which centrifugal force is perfectly balanced. In general, the practice is to superelevate all curves having a radius of 300 ft. or less, with special consideration for curves of greater radius on steep gradients and of considerable length. After numerous experiments with superelevation ranging from ½ to 1 in. per foot, a standard for all curves has been adopted at ¾ in. per foot. It has been found that the theoretically correct speeds for a ¾-in. per foot superelevation on a

15-ft. roadway are as follows for curves of different radii:

Radius, ft.	Speed, miles per hour
300	16 to 18
250	15 to 16
200	13 to 14
150	11 to 12
100	10

This table has been based on the finding that almost invariably the speed of motor vehicles varies directly with the radius of the curvature, and if this assumption is true, it has been pointed out that theoretically, as well as practically, the adoption of a constant rate of superelevation is warranted within the limited radii under consideration.

In constructing concrete pavements the method of transition from crowned to superelevated sections is indicated in the accompanying drawing. This layout has been adopted after trials of numerous methods of joining such sections and an observation of how traffic is affected. It is recommended that different templates be used so that smooth curves of a gradually changing section are obtained. Whether the work is done by hand templates or by machine tamper, the setting of the header boards is of utmost importance, and they should be carefully checked before "striking off" by either method.

On a mountainous section of the highway, where a great deal of curvature was necessary, and where the foregoing principles were rigidly adhered to, Walter C. Howe, resident engineer in charge, has stated: "It is probable that considerable objection will be made to this method and the arguments advanced that the center line of pavement should be true to grade and the superelevation accomplished by depressing the inner edge and raising the outer edge of pavement equally. This has been tried out on numerous occasions, but better results have been obtained by the method just described."

Exclusive Rainfall Reported

Supplementing the information regarding the recent flood in West Virginia, as given in the last two weeks' issues of this journal, Mayo Tolman, director of sanitary engineering of the State Department of Health, reports a precipitation of 5.8 in. in 3½ hours at Kayford. The flood wave traveled 18 miles in 2 hours 20 minutes between Kayford and Cabin Creek junction.

Failure of Roxbury School Building Apparently Caused by Faulty Brick Piers

Sanford E. Thompson Reports Investigation of Collapse of 63 x 203-Foot Structure Having Four-Way Reinforced-Concrete Floor Slabs

FOLLOWING the failure of the shop building of the Boys' Industrial School at Boston, Sanford E. Thompson, consulting engineer, of that city, made thorough examinations of the structure and reported, as a result of computations of strength, tests of the materials and tests of samples cut from the actual construction, that the cause of collapse was the failure of brick piers between the first and second floors, due to improper design, poor quality, freezing temperatures and the use of lime-and-cement mortar.

The building, 63 x 203 ft. in plan, consisted of two stories and basement for the front three bays, about 61 ft. in length, and one story and basement for the rear portion. The floors and roof were constructed of four-way reinforced-concrete flat slabs, supported in reinforced-concrete interior columns spaced about 22 ft. apart and on wall beams on brick piers, with brick walls. To give proper slope to the roof a cinder concrete fill with 2-in. mortar surface was used, varying in thickness from 17 to 3 in. This concrete had been placed on the high point of the roof on the day before the failure, when the weather turned warmer, tending to take the frost out of the masonry.

The conclusions and extracts from Mr. Thompson's report indicating the principal features of this failure follow:

CAUSES OF COLLAPSE

"The evidence points clearly to the brick piers between the first and second floors as the place of initial failure. The cause of the failure of these piers we find to be due to (1) their improper design for carrying a long-span flat slab; (2) the quality of the brickwork, which was not adapted to sustain the normal load of the long-span slabs; and (3) the use of lime-and-cement mortar, where the specifications called for cement mortar.

"If the structure had been built with properly designed concrete wall columns, it undoubtedly would be standing to-day.

"In reaching the foregoing decision, due account is taken of the fact that the concrete in the floors and roof at time of collapse was not thoroughly hard, and in fact had not attained nearly the normal strength of concrete. I find, however, by actual test of the strength of the column concrete that the columns were amply strong to carry the load; also, from my knowledge of the action of flat slabs even of partially hardened concrete, I consider that such a sudden failure as wrecked the building could not have been produced by the failure of the slab.

HISTORY OF CONSTRUCTION

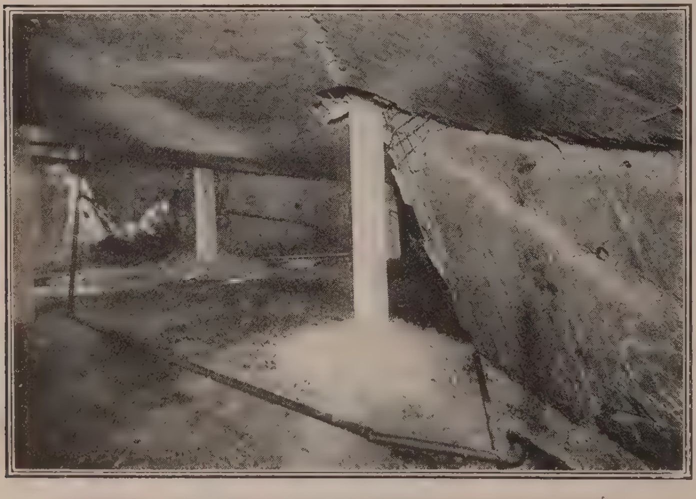
"From an inspection of the original records on the job I have the following information:

Location	Concrete poured	Forms removed
Basement columns	Nov. 24, 1915	Dec. 9 and 10, 1915
First-floor slab	Dec. 1, 3 and 4	Dec. 24, 27, 28 and 31
Columns supporting second floor and roof (low)	Jan. 5 and 6, 1916	Feb. 10, 11, 12 and 19
Second floor and low roof	Jan. 6 and 7	March 6, 7, 8, 9, 20 and 22
Columns supporting high roof and high roof itself	Feb. 2 and 5	Feb. 29 (column)
Cinder fill on low roof	Jan. 24, 25 and 26	March 22 (posts next to wall)
Cinder fill in high roof	March 23	

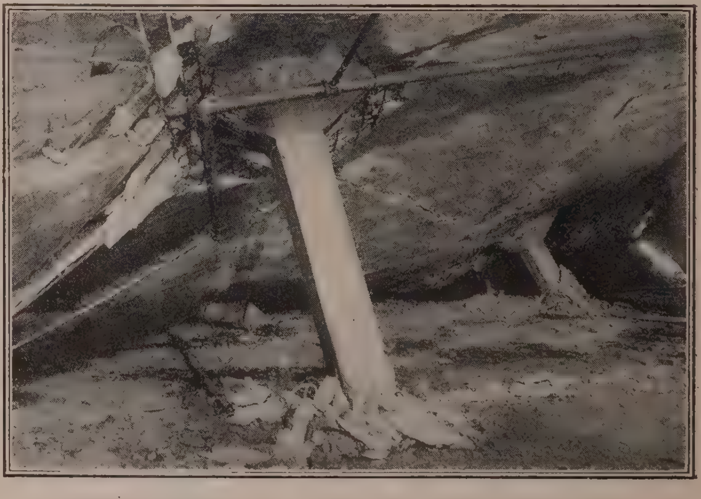
Collapses occurred March 24, 25 and 29.

"I understand that the sand and stone for the concrete were thoroughly heated. I am advised also that the brickwork was laid in advance of the concrete construction, that the window openings were protected by canvas, that salamanders were used on the floors, and the fresh concrete protected.

"The foregoing table shows that the forms under the second floor and low roof were left in place more than eight weeks. Occasional 3 x 4 in. posts spaced about 11 ft. apart were under the low roof at the time of my first visit after the first collapse. Before removal of the forms, I am advised that the concrete was examined and tested by blows in the presence of the city building inspector.

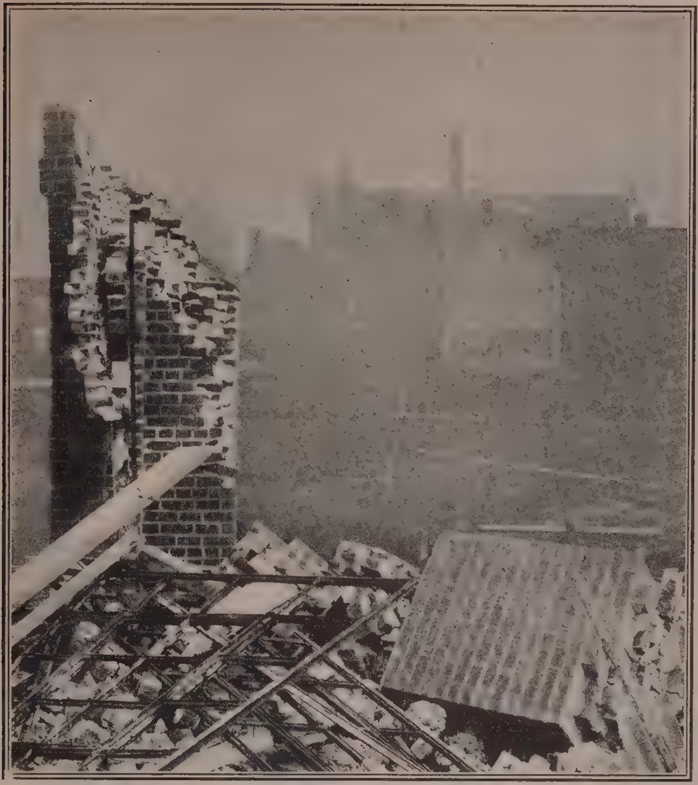


BASEMENT COLUMNS SUPPORTING BROKEN FIRST-FLOOR SLAB

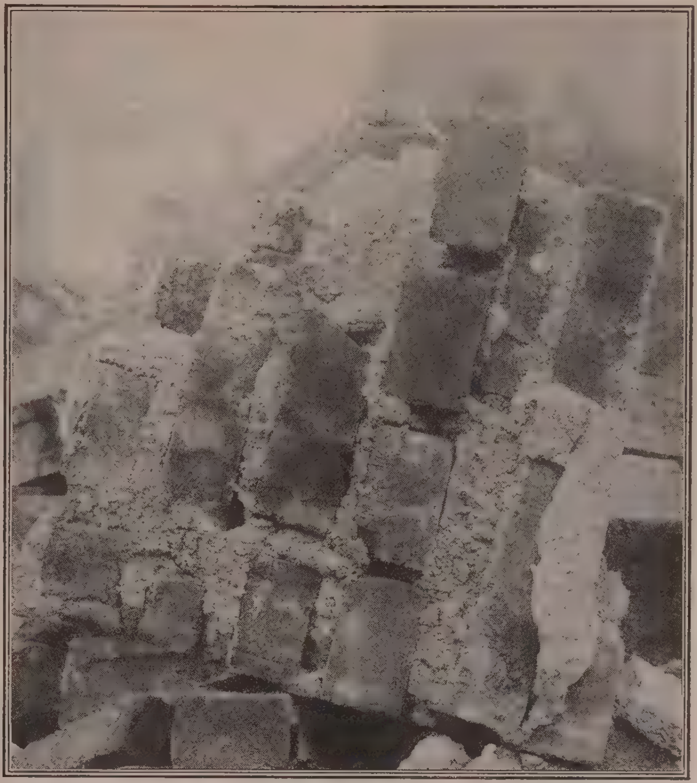


CRUSHED FIRST-FLOOR COLUMNS STILL CARRY HEAVY LOADS

Note the remarkable toughness of the slabs and columns which survived excessive loads and impact from the collapsed upper floors and posts



VIEW OF BRICK PIER AT CORNER SHOWING VERTICAL JOINT



NEARER VIEW INDICATING NATURE OF MORTAR WORK

"At the time of my first visit on March 25 I found the roof and the second floor of the high portion of the building had collapsed and were hanging on the reinforced-concrete beam which was designed to support the rear wall of the second story. The remainder of the building remained intact. On the following day I was advised of a further collapse at 7 o'clock the night previous, and again visited the job. I found the low roof had fallen, bringing with it a part of the first floor at the south end of the building. The first floor in the north end, although badly deflected and cracked, and the column cap badly cracked, held the weight of the entire material of the second floor and roof, besides having sustained the impact of the fall.

"Not until three days later, on March 29, did this portion of the first floor finally fall, leaving even the basement columns still in a nearly vertical position.

Frozen Mortar in Brickwork

"The mortar in the brickwork was, much of it, frozen, and the part which had thawed easily crumbled in the fingers. From the appearance it was evidently a lime-and-cement mortar, with a preponderance of lime. This afterward proved to be the case by chemical test. The brickwork was not constructed with the care required for piers or a wall supporting a long-span slab. The horizontal joints varied in thickness ranging up to 1⅝ in. The vertical joints were, many of them, open for a depth of several courses. Headers in some cases were blind instead of being full. The face brick in many cases was peeled off from the backing, and cracks between them are shown in the photographs. The piers between the windows in the top story of the main building, which were laid under conditions corresponding to those of the shop building, were found by measurement to have buckled, the face course being bulged out from the backing. As a whole, the brickwork in the shop building was very poorly constructed for carrying out the intent of the design.

"The concrete in the second floor and the roof slabs was not thoroughly hard. It contained moisture and some frost. I found a marked difference in the concrete, however, in different portions of the structure. The columns both in the basement and the first story appeared well hardened. This was shown by inspection and also by the fact that in places the surface of the column had been chipped with a cold chisel without crumbling. The concrete in the low roof slab was least hard and very much weaker than the concrete of the second floor, which was laid as a part of the same slab. The harder condition of the floor slab was due evidently to the better protection from the cold and the opportunity to dry out.

"The concrete of the roof slab was well bonded with the cinder concrete fill, so well, in fact, that they would act together in resisting stress.

Criticism of Design

"My criticism of the design relates chiefly to the improper combination of the reinforced-concrete flat slab with the brickwork. Such combination is a poor construction at the best, and, if unavoidable, special precautions should have been taken to provide for eccentric stresses and bending moments. Even the slight normal deflection of the slab which occurs under working loads tends to throw excessive stresses on the brick piers because of the eccentricity.

"In the slab design I would criticise especially the shape of the haunch, which is flatter than required by good authorities at the time of the design of this building.

"Turning to the walls, we find a 12-in. thickness for the two upper stories (4 in. of this being face brick), a quality of construction very poor for the requirements, and a mortar consisting largely of lime and sand. I am informed also that instead of slaking the lime in advance, it was slaked just before using. As evidence of this, I find at various places in the mortar small pieces of unslaked lime. The mortar materials, I am advised, were not heated. Computing the stresses, I find that on account of the weight of the long span the brickwork probably received a stress of more than 250 lb. per square inch, whereas tests of a portion of one of the brick piers showed the beginning of failure at 167 lb. per square inch.

Results of Tests

"The specifications for piers require 1 part cement to 3 parts sand, with not to exceed a shovelful of slaked lime to a bag of cement. Samples from the wall where the failure first occurred represent approximately 1 bbl. of lime to 1 bbl. of cement. Allowing for the expansion of lime in slaking, we find instead of one shovelful of slaked lime per bag of cement (the limit of the specifications) 13 shovelfuls, 15 shovelfuls and 4 shovelfuls of slaked lime respectively for three samples of mortar analyzed chemically.

"*Brickwork*—Two pieces of brickwork from brick piers in the portion of building which collapsed were tested for compression. The first sample showed a drop of the gage of the testing machine at 167 lb. per square inch, or 12 tons per square foot, showing that a constant application of this load would have produced failure. The specimen actually broke at 550 lb. per square inch, or 40 tons per square foot. The second specimen showed initial failure at 240 lb. per square inch, or 17 tons per square foot with a breaking strength of 635 lb. per square inch, or 46 tons per square foot. It is of course evident that the lower figures represent the actual value of brickwork in resisting the load.

"*Concrete*—Chemical analysis of the concrete showed it to be in proportions 1 part cement to 6 parts of aggregate, or substantially 1 part cement to 2 parts sand to 4 parts stone, as called for by the specifications. A sample of this concrete hardened satisfactorily upon boiling, indicating its good quality and the fact that the low strength was due simply to the cold-weather conditions.

"A sample of the concrete corresponding to the concrete in the column between the first and second floors of the part of the building that failed first showed a strength in compression of 1350 lb. per square inch, which is very much in excess of the stresses found by computation as caused by the loads. No specimen of the slabs large enough to test could be obtained from the end of the building which first collapsed without endangering the men making the test. Inspection of the concrete, however, indicated it to be strong enough to carry the loads which came upon it.

"In view of these conditions and as a result of examination, computations and tests, I am convinced that the failure of the building originated with the brick piers supporting the second floor. The conditions on March 24, the position of the columns and the rest of the failed portions, indicate that the subsequent failure started at the junction with the ruins of the first mentioned failure."

Eccentric Loading on Columns Discussed, Accompanied by Formulas and Table

Moments Caused by Crane Loads in Mill Buildings and by Eccentric Loads in Office Buildings Can Be Found by Approximate Methods

By R. FLEMING
American Bridge Company, New York City

BUILDING CODES and specifications usually contain a clause stating that in proportioning columns provision must be made for eccentric loading. That some provision should be made is self-evident, but just what that provision should be is a matter of discussion. This article presents methods that have been used satisfactorily, are easy of application, and for all practical purposes are near enough to being correct.

LOADS ON BRACKETS

The most common cases of eccentric loading are those of crane runway girders carried on column brackets. In Fig. 1 the load P acts at a distance m from the center of the column, and the couple Pm is held in equilibrium by a horizontal couple Wc. Then

$$Pm = Wc \text{ or } W = Pm/c$$

If M_b is the moment at bottom of column where R_b is the reaction, M_t moment at top of column where R_t is the reaction, M_1 moment at point A and M_2 moment at point B, then for columns with both ends considered hinged it is easy to write:

$$M_b = 0 \text{ and } R_b = -\frac{Wc}{l} = -\frac{Pm}{l}$$

$$M_t = 0 \text{ and } R_t = \frac{Wc}{l} = \frac{Pm}{l}$$

$$M_1 = R_t d = \frac{Wcd}{l} = \frac{Pmd}{l}$$

$$M_2 = R_b a = -\frac{Wca}{l} = -\frac{Pma}{l}$$

The bending-moment diagram for ends hinged is shown by Fig. 2.

If both ends are considered fixed, we have the following equations, furnished the writer by his colleague, Stanley Smith:

$$M_b = \frac{W}{l^2}\left[-d^2(l-d) + a(l-a)^2\right]$$

$$R_b = \frac{W}{l^3}\left[d^2(3l-2d) - (2a+l)(l-a)^2\right]$$

$$M_t = \frac{W}{l^2}\left[-(l-d)^2 d + a^2(l-a)\right]$$

$$R_t = \frac{W}{l^3}\left[(l-d)^2(l+2d) - a^2(3l-2a)\right]$$

$$M_1 = \frac{W}{l^2}\Big[-d(l-d)^2 + a^2(l-a) + \frac{d}{l}(l-d)^2(l+2d) - \frac{d}{l}a^2(3l-2a)\Big]$$

$$M_2 = \frac{W}{l^2}\Big[-d^2(l-d) + a(l-a)^2 + \frac{a}{l}d^2(3l-2d) - \frac{a}{l}(l-a)^2(2a+l)\Big]$$

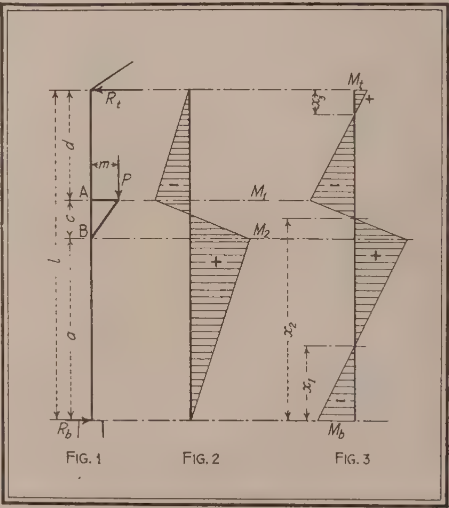
The bending-moment diagram for ends fixed is shown by Fig. 3. The points of contraflexure x_1, x_2 and x_3 from the ends can easily be located by plotting the values of the moments, as indicated by the figure.

In the table herewith the values of M_b, M_t, M_1 and M_2 are given in foot-pounds for both fixed and hinged ends when P is taken at 10,000 lb., l is 24 ft., m is 18 in. or 1½ ft., c is assumed constant at 2 ft. and a and d vary in accordance with the vertical position of the bracket.

MOMENTS IN 24-FOOT COLUMN DUE TO 10,000 POUNDS 18 INCHES FROM CENTER

		Hinged Ends		Fixed Ends			
a	d	M_1	M_2	M_b	M_t	M_1	M_2
6	16	10,000	3,750	1,354	4,896	7,461	5,990
8	14	8,750	5,000	1,147	4,896	7,383	5,872
10	12	7,500	6,250	3,021	4,271	6,875	6,263
12	10	6,250	7,500	4,271	3,021	6,263	6,875
14	8	5,000	8.750	4,896	1,147	5,872	7,383
16	6	3,750	10,000	4,896	1,354	5,990	7,461
18	4	2,500	11,250	4,271	4,479	6,940	6,823
20	2	1,250	12.500	3,021	8,229	9,049	5,143
22	0	0	13,750	1,147	13,647	12,604	2,096

An effort is usually made to fix columns at the base by set anchor bolts and at the top by rigid attachment to a truss or girder. The actual condition, however, is between fixed and hinged ends. An easy method of calculation is to assume the maximum bending moment to be 8/10 or 9/10 of that obtained from ends considered hinged. This is a close approximation, as may be inferred from the maximum values in the table.



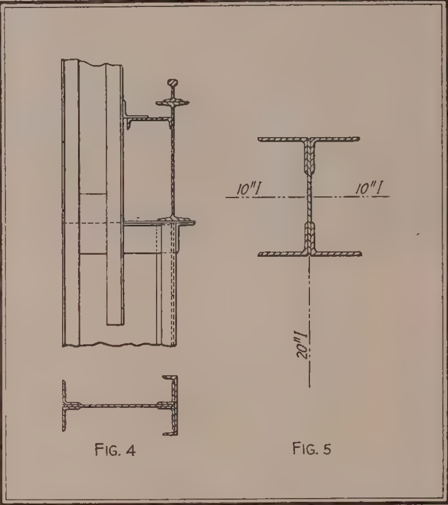
FIGS. 1, 2 AND 3—ECCENTRIC LOAD ON COLUMN

In proportioning parts for the combined stresses due to bending and direct loads the allowable working stress is increased 20 per cent, provided the section thus obtained is not less than that required for bending or direct stress alone.

The specifications for a building of unusual magnitude contain the clause:

> No cantilever brackets for crane loads shall be used when capacity of crane is in excess of 10 tons.

This is an excellent rule for all buildings. It is better to avoid eccentricity than to make provision for it. Where practicable, columns as in Fig. 4 should be used. The crane load should be carried to the base by the channel and the two connecting angles with the portion of web plate between them.



FIGS. 4 AND 5—CRANE AND BUILDING COLUMNS

OFFICE-BUILDING COLUMNS

In office buildings eccentric loading on columns is usually caused by unbalanced floor loads. Fig. 5 is a familiar instance. If the column were turned 90 deg. there would be little or no eccentricity, but columns cannot always be turned in order to lessen eccentricity.

A practice sometimes followed in office-building design is to neglect eccentricity altogether. This is reprehensible and needs no comment. Another practice is to add the flexural unit stress found by a formula for eccentric loads to the unit stress due to direct load, and to proportion the column so that the combined stresses do not exceed the allowable unit stress obtained from the formula used for axial compression. This method is more severe than need be, as office-building columns are continuous through two or more stories. It is probably for this reason that the Bethlehem Steel Company's handbook permits the maximum fiber stress due to direct load and bending to be 25 per cent in excess of the permissible stress on the column obtained from the formula for concentric loading. Burt, in "Steel Construction," 1914, writes:

> Some authorities allow three-fourths of the bending moment to be used in computing the effect on the column. This practice is satisfactory and is followed in the illustration used later in this book.

Ernst F. Johnson, in "The Theory of

Continuous Columns" (*Transactions* of the American Society of Civil Engineers, June, 1906), finds the bending moment caused by eccentric loading on office-building columns to be $M = W(c + b/2)$, in which W is the load, b the eccentricity, and c a constant to be deduced from the particular building law or specification under which the work is to be erected. From the New York building code he finds the value of c to be 1/16 in. per foot of column length.

HELLER'S INVESTIGATIONS

Heller, in "Stresses and Structures," finds for a ten-story building that the maximum bending moment of a column with equal loads P and equal eccentricities e at all floors, is at the roof line or top of the column and equal to Pe. At the top of the second segment from the bottom the moment is 0.39 Pe. For intermediate points (three stories or more from the top or bottom) the moment is 0.5 Pe. For a single load at any point, the bending moment in the column passes from a value of about +0.5 Pe just above the load, through zero to a value of about —0.5 Pe just below the load.

In "Stresses in Tall Buildings," by Cyrus A. Melick (Ohio State University Bulletin No. 40, June, 1912), Chapter 4 is devoted to a study of the effect of eccentric loading on columns. The conclusions pointed out by Heller are verified. The author presents his own theory in Chapters 7 and 9, and in the final chapter he gives a "résumé of all findings and suggestions for designers as derived therefrom," in which he writes:

> It is evident, then, that it is not safe practice to follow the conclusions deduced in Chapter 4, which are identical with Professor Heller's. It is further shown that the value of the bending moment may materially exceed even the quantity Pe so commonly used by designers. Also, it is shown that the bending moment is not a constant throughout the story height but reverses in sign, and at the foot of the column it may be a much larger quantity, of opposite sign, than the moment at the top of the column.

The findings and suggestions of Melick have not been used to any appreciable extent by designers.

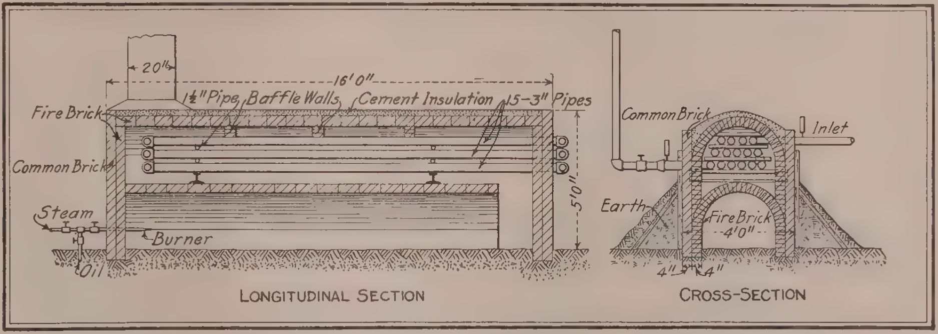
For the usual office-building column with an eccentric load the practice of the writer is to use three-fourths of the bending stress found by Rankine's formula for eccentric loads. As in proportioning mill-building columns, the allowable working stress is increased 20 per cent for the combined stresses due to bending and direct loads, provided the section thus obtained is not less than that required for bending or direct stress alone.

In conclusion, the writer believes that more attention should be given to the details of eccentric connections than is done at present. Good detailing is fully as important as, and often more difficult than, determining stresses and proportioning parts.

Asphaltic Road Oils Heated Quickly in Retort

Permanent Plants That Can Heat 6000 Gallons Per Day to 375 Degrees Are Installed in California for About $2,000

IN applying thin bituminous surfacing to concrete pavements according to the specifications of the California Highway Commission an asphaltic base oil is used, refined to the point where the asphalt content is 90 per cent. To spray this heavy oil on the surface in two coats, of ¼ gal. per square yard each, it is necessary to heat the oil to high temperature. In order that this may be done economically a very careful study of the conditions was made and the practice, in large measure, standardized as described in the following notes.



THE RETORT IS DESIGNED TO MINIMIZE HEAT LOSSES FROM INCOMPLETE COMBUSTION OF FUEL AND FROM RADIATION

Two types of oil-heating stations are used. Where only comparatively small quantities of oil are required, semiportable plants are installed at the nearest railway siding, and are moved to other locations when the work is completed. But when the area of operations extends from 20 to 30 miles in either direction the economics of a permanent plant warrant the more expensive construction. These oil-heating plants were referred to briefly in a report on California road construction and maintenance, published in the Engineering Record of May 6, 1916, page 603.

HEATING-PLANT LAYOUT

In both types of installation the cycle of operations is practically the same and the unit members of the equipment are similar. Cars of oil are unloaded by gravity into storage tanks or pits varying in capacity from 10,000 to 25,000 gal. and the oil is delivered thence to trucks by pumping. Steam coils in the tank cars are necessary in order to heat the oil so it will flow. The same requirement holds for the storage pit or tanks, and a retort is necessary for heating the oil up to the high temperatures at which it is delivered to the trucks.

The drawing shows the design of the retort for heating the oil in what is practically a tubular boiler. In semiportable installations the storage tank is usually made of steel, and in permanent plants a concrete sump is used, the capacity in each case being determined by the availability of the oil supply. The hot-oil pump in most general use is a 6 x 4 x 6-in. duplex piston pump, oil fitted.

The circulation tank, or oil pit, is either a concrete-lined sump, a reinforced-concrete box, or a steel tank, with a capacity between 2000 and 3000 gal. It is heavily piped with steam coils and is tightly covered. In some cases where the large oil storage tank is a concrete sump this circulation tank is made as a chamber of the larger tank, but is always separated from it by concrete walls.

IN THE GALVANIZED IRON BUILDING BESIDES THE RETORT ARE THE STEAM BOILER AND THE OIL PUMPS

OIL HEATED QUICKLY

It has been found that the time saved in handling the oil rapidly makes it very desirable to secure a quick-heating retort. Saving time in loading trucks increases the output of the plant and thereby reduces the cost per barrel for heating, inasmuch as the daily operation charges are practically fixed, irrespective of the quantity of oil treated. The type of retort illustrated herewith has been designed to reduce to a minimum losses from incomplete combustion of fuel and from radiation. The long firing chamber allows complete combustion of fuel oil and the large number of pipes that practically fill the upper arch absorb the maximum of the heat. The design shown keeps radiation down so low, it is stated, that it is possible to place the hand upon the retort at any point during heaviest firing. The number and lengths of pipes were determined by dividing the square feet of heating surface required into some number of convenient lengths for handling. The 3-in. pipe was taken as giving the maximum heating section without introducing undue friction. To determine the square feet of heating surface needed it was first ascertained by various experiments and trials that it would be necessary to raise the temperature in the oil while passing through the retort coil about 200 deg., when loading into trucks.

SPEED OF OPERATION

To put a truck load of 1000 gal. through in a short time, say 20 to 25 minutes, without burning pipes and without preheating to excessive temperatures in the circulation tank, required about 150 sq. ft. of heating surface, with a furnace temperature of 1800 deg. to 2000 deg. Fahr. (this being the maximum that can be carried with safety). The calculations were based on 3 B.t.u. per hour per square foot of heating surface, per degree of mean temperature change, which accuracy of assumption was accepted for temperatures up to 300 to 325 deg. Fahr.

A feature of this retort design which has been found very useful is that of carrying the pipe at once to the outside of the retort and, in place of return bends, using a special fitting which permits the removal of the ends of individual pipes so that access may be had to each of them to clean out the carbon which is continually deposited in slight quantities.

OPERATING METHODS

In preparing to deliver oil to a motor truck, warm oil is first pumped from the storage tank through the retort and into the circulation tank. As soon as the circulation tank contains a truck load the suction from the main storage is closed and the oil in the circulation tank is re-run until it has reached at least 200 deg. The retort fire is then increased and the oil pumped through direct to the truck tank at temperatures from 325 to 375 deg. Fahr. The entire operation of circulation and loading consumes about 1½ hours, so that it is possible to load about six 1000-gal. oil trucks per day from a plant laid out and operated on the lines just described.

When the oil is to be conveyed less than 10 miles in trucks, it is delivered to the trucks at 325 deg. Fahr. For distances greater than 10 miles, the specified temperature is 350 deg., the desideratum being a temperature of approximately 300 deg. Fahr. at the time of application. The commission has found that at this temperature the more fluid condition of the oil provides a better bond with the concrete than is obtainable with temperatures considerably lower.

COSTS

A completely equipped oil-heating plant of standard type described in the foregoing has cost the commission approximately $2,000, installed. Records of costs covering unloading from tank of cars, heating and loading into motor truck tanks on approximately 5000 bbl. of 90 per cent asphalt road oil show a total expenditure for labor and fuel, repairs and supplies, interest and depreciation, of about $2,250, or 45 cents per barrel of road oil unloaded and delivered hot.

A. B. Fletcher is chief engineer of the California State Highway Commission. Walter C. Howe is resident engineer of Division 5.

Double Tank Proposed for Residential Sewage Plants

Better Operating Results Claimed for Septic and Imhoff Units in Series—"Greenhouse" Sludge Bed Advocated

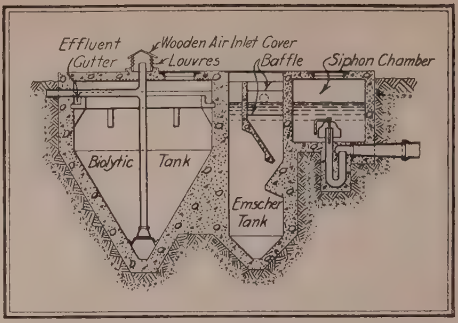
By WALDO S. COULTER
Of Hansen & Coulter, Consulting Engineers, New York City

RESIDENTIAL sewage-disposal plants are usually constructed after a fixed pattern that has undergone little or no modification since its inception in the days of Colonel Waring. Such installations usually consist of a single-story septic tank followed by a siphon chamber and some simple form of secondary treatment.

Engineers and superintendents who have been associated with the practical operation of the single-story, horizontal-flow tank know that, unless operated as a plain sedimentation tank, with frequent cleanings, it is a very unsatisfactory sedimentation device. During hot weather gas discharges from the sludge deposits on the tank bottom commence about three weeks after placing the tank in service. During the winter from six to eight weeks usually suffice to establish active ebullition in northern latitudes.

"UNLOADING" HINDERS SEDIMENTATION

Gas production is accompanied by such disturbances of the tank contents that efficient sedimentation is precluded and suspended matter appears in the effluent in considerable quantities. This "unloading" goes far toward explaining the phenomenon of the septic tank that has been in operation for several years and yet contains less than 50 per cent sludge. The writer has never seen any arrangement of baffles that prevented unloading from a single-story tank in active ebullition.

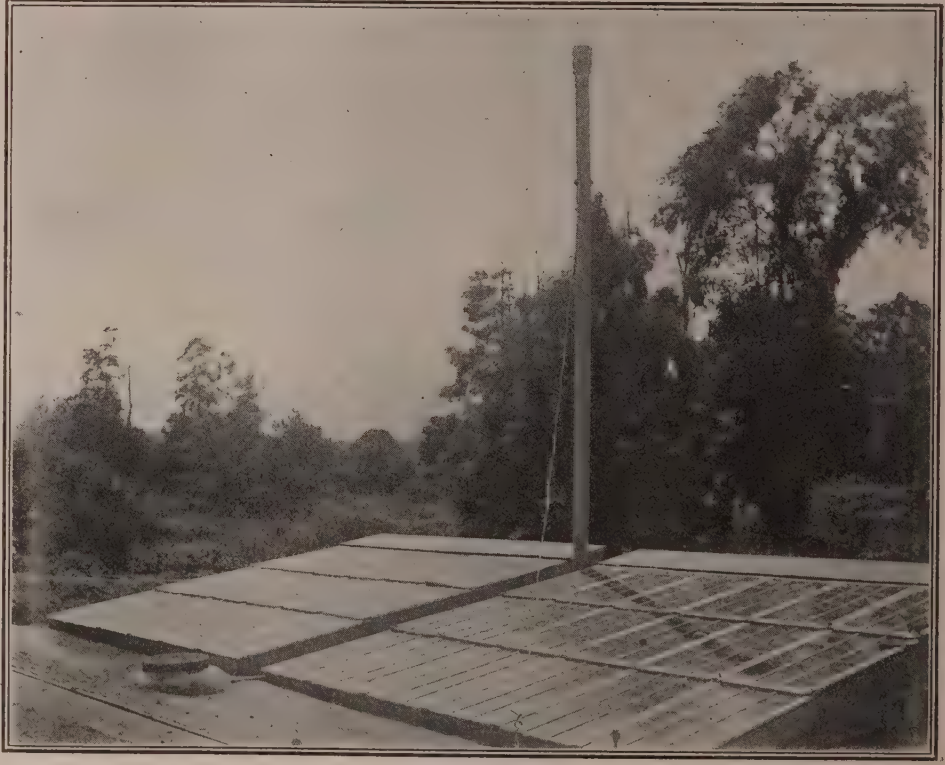


SUGGESTED ARRANGEMENT OF SEPTIC AND IMHOFF TANKS FOR RESIDENTIAL SEWAGE PLANT

If the tank is cleaned as soon as septic action begins very good results can be secured. This is not ordinarily admissible in the case of the residential plant, where such constant cleaning cannot conveniently be done, and where the proximity to dwellings makes a nuisance quite probable if undigested sludge is handled.

Soon after being placed in service the tank of the standard-type residential plant begins to unload into the tile field, sand filter or contact bed that provides secondary treatment. The field or bed is soon choked up with sludge, and constant scraping is necessary to keep the filter in service. Choked tile fields, where the sewage appears at the surface to form "wet ground," and whence the water is dissipated by evaporation or by seepage into adjacent unclogged areas, are common. The owner very often supposes that this is as it should be and makes no protest unless the stench becomes pronounced.

The common septic tank has, nevertheless, certain advantages as applied to residential installations that the two-story type does not possess. Residential sewage arrives at the tank in a fresh condition with unbroken fæces, paper intact, and having a higher percentage of grease than commonly appears in municipal sewage. These matters pile up against the scum baffles of an Imhoff tank or adhere to the slopes of the settling channel and call for unusually painstaking attention.



"GREENHOUSE" TYPE OF SLUDGE BED AT PLEASANTVILLE, N. Y., HAS 648 SQUARE FEET OF GLASS

The logical arrangement for the residential plant, which will be found desirable in many larger plants as well, appears to the writer to be a septic tank and a short-period Imhoff tank, placed in series. The two-story tank then serves to intercept matter carried over from the septic tank and, if given reasonable attention, should insure a well-clarified effluent. The Imhoff tank should be provided with light, strong checkered plate covers to allow unobstructed access to the slopes and gas vent. In the opinion of the writer, the upward-flow type possesses advantages peculiarly fitting it for the primary tank in such a series, the influent being admitted at a point near the bottom and caused to pass upward through the sludge accumulation, after the manner of the Boston biolytic tank, so called, suggested by Professor Phelps.

Two principal faults have heretofore appeared in the operation of tanks of this type:

First, suspended matter unloads. This has been aggravated in most upward-flow tanks by improper design, which has permitted too high velocities. Unloading is, however, characteristic of this as well as of horizontal-flow, single-story tanks. The Imhoff tank in series would correct this deficiency.

Second, foul odors are produced. This may be overcome to a considerable extent by carrying the influent pipe above the outside of the tank in such a manner that the inflowing sewage entrains sufficient air to enter the sludge stratum saturated with oxygen. The sludge layer acts not only as a strainer to intercept true suspended matter, but the colloids and fats are thrown out by adsorption. The writer is aware of the fact that this type of tank produced considerable amounts of hydrogen sulphide at the Chicago Sewage Testing Station, but this action has not been duplicated elsewhere to his knowledge, and the fact remains that it was by far the most efficient clarification device at the station. Sludge containing entrained gases and rising from the tank bottom to appear in the effluent will readily settle again if subjected to such agitation as ordinarily occurs at collecting troughs or outlet weirs. A simple test at any septic tank will readily demonstrate this condition.

"GREENHOUSE" FOR SLUDGE DISPOSAL

The removal and disposal of sludge are other matters which have usually been accorded scant attention in residential and institutional plants. Too often plants of considerable size are provided with no means for the withdrawal of sludge other than by pails or buckets passed up through manhole openings in the cover slab. Disposal in the vicinity of the plant is avoided because of probable nuisance.

The solution of this problem may, in the opinion of the writer, be frequently found in the glass-covered or "greenhouse" type of sludge-drying bed, with vent stack and air-inlet openings. To his knowledge, the first operative bed of this type was designed by him while connected with the firm of Lederle & Provost, of New York City, and installed and operated under his direction at the plant of the Hebrew Sheltering Guardian Society at Pleasantville, N. Y. It was constructed and placed in service during the summer of 1915. The results have exceeded expectations. Plain sedimentation sludge dries sufficiently to permit removal in from ten days to two weeks, and the action of the bed is unaffected by rainy weather.

Last winter the bed operated efficiently and without freezing, although no artificial heat was applied. One unit was built first in order to observe its behavior, particularly with regard to odors, as it is located about 200 ft. from the nearest of several dwellings. This unit was entirely successful and a second one was afterward constructed.

AËRATION OF TILE FIELDS

Referring to tile fields, one defect which may be noted among others is lack of aëration. In any oxidizing unit, such as a tile field, oxidation is accompanied by the production of a considerable volume of carbonic acid gas, which should be removed from the system as rapidly as formed, since it operates to retard or prevent oxidizing action. This gas is heavier than air and, in the case of a sprinkling filter say, built above the ground surface, tends to sink to the lower portion of the filter and escape through the under-drains, etc. The tile field, being entirely below the ground surface, retains the CO_2 in the soil pores and tiles, excluding the air, until displaced from time to time by applications of sewage. This must markedly reduce the efficiency of the field. An evident improvement would be to connect the ends of the tiles at one side of the field with a ventilation duct terminating in a vent stack with a ventilating hood, the opposite ends being provided with suitable air inlets.

Further constructive criticisms could be made, but enough has been written to call attention to the fact that the standard type of residential sewage-disposal plant is deficient in many respects and merits a portion of the attention that has been heretofore almost entirely devoted to larger installations.

Road-Maintenance Stations for California Highways

Depots Make It Possible to Supply Materials for Repair Work to Remote Sections of State Highway System

THE California State Highway Commission has established maintenance stations along the highways which are to fulfill a twofold purpose—namely, to maintain the roads in their original first-class condition and to be able to deliver, at the proper temperature, oil used in surfacing or resurfacing the pavement. In many localities the latter function is very important because of the great mileage of roads to be surfaced, and it has been found economical to use first-class permanent construction in building the heating plants.

An example of the policy in the location and construction of these maintenance stations is afforded by the three main yards in Division 6, which embraces nine San Joaquin Valley counties. In this division there were 150 miles of highway to be surfaced when the maintenance station was laid out, and altogether a total of 180 miles to be maintained.

THIS BROKEN GUARD RAIL WAS REPAIRED QUICKLY WITH MATERIAL DELIVERED BY MOTOR FROM CALIFORNIA MAINTENANCE STATION

The first station in this division was built at Merced, and was used as a distributing center from which 40 miles of pavement were oiled. The second station was located at Fresno and the third at Bakersfield. About 40 miles have been surfaced with materials distributed from the Bakersfield station. All three of these stations are on property which the state bought outright, as it has been found advisable to build permanent structures only on land owned by the state.

STATION EQUIPMENT

These stations are situated so that it is possible to unload the heavy asphaltic oil directly from the railroad tank cars in which it is delivered, into concrete storage pits. The stations are provided with steam generating equipment with which to heat the oil and to drive the pumps and heating retorts. This oil-handling equipment is designed and constructed on permanent lines, so that the oil may be handled with a minimum of time, labor, expense and trouble. The latter item has been found to be a very important one, but its significance will be appreciated only by those who are familiar with the possibilities in this direction when handling heavy asphaltic oil if all conditions are not just right.

In addition to the central maintenance stations where road building materials, equipment and tools are stored, there are also structures known as "shelter houses," built on some of the longer stretches of highway where it is occasionally very convenient to have small tools near at hand.

With a subdivision of the system on this basis it is possible, for example, to get materials for repair work to the most remote portion of the 125 miles of highway surfaced from the Fresno station within less than four hours. The equipment for a "flying squadron," depending on motor trucks for rapid transportation, is kept in readiness for emergency service and has proved very effective and well worth the incidental cost.

Austin B. Fletcher is chief engineer of the California State Highway Commission and James W. Woodson is resident engineer of Division 6.

Literature

For the Civil Engineer and Contractor

New Publications

PROCEEDINGS OF THE TENTH ANNUAL CONVENTION OF THE SMOKE PREVENTION ASSOCIATION, 1915. Paper, 6 x 9 in.; 176 pages; illustrated. Chicago, 608 City Hall, Frank A. Chambers, secretary-treasurer.

DUST EXPLOSIONS AND FIRES IN GRAIN SEPARATORS IN THE PACIFIC NORTHWEST. By David J. Price, engineer in charge of grain dust explosion investigations, Bureau of Chemistry, and E. B. McCormick, chief, division of rural engineering, Office of Public Roads. Bulletin 379, U. S. Department of Agriculture. Paper, 6 x 9 in.; 22 pages; illustrated. Washington, Government Printing Office.

TRUST LAWS AND UNFAIR COMPETITION. By Joseph E. Davies, commissioner of corporations, U. S. Department of Commerce. Paper, 6 x 9 in.; 832 pages. Washington, Government Printing Office.

SUPPLEMENT TO MECHANICS' LIENS AND GENERAL CONTRACTING. By Thomas H. Ray, of the New York City Bar. Cloth, 6 x 9 in.; 819 pages. Albany, Matthew Bender & Company, Inc.

Contains the amendments to these laws up to the close of the New York legislative session of 1916, with all of the decisions since the date of the original work—July, 1914, to June 1, 1916.

CONCRETE SEWERS. Paper, 6 x 9 in.; 43 pages; illustrated. Chicago, Portland Cement Association.

Booklet for free distribution gives information on the merits of concrete in sewer construction, with history and examples of use.

Books Reviewed

Highway Engineers' Handbook

Authors, Wilson G. Harger, first assistant engineer, and Edmund A. Bonney, supervising engineer of the New York State Highway Department. Second edition, revised and enlarged. Flexible covers, 4¼ x 7 in.; 609 pages; illustrated. New York, McGraw-Hill Book Company, Inc. $3 net.

The second edition of Harger and Bonney's "Highway Engineers' Handbook" contains about 100 pages of new material, and represents a revision of the first edition, published about four years ago and reviewed in the Engineering Record of September 28, 1912, page 363. The material on top courses has been brought up to date, and data on tests, designs, costs and maintenance and specifications have been added. The index also has been amplified, and rearranged systematically, although the general make-up of the book remains unchanged.

The book is divided into two parts, the first dealing with the principles of design and the second with the practice of design and construction. In Part 1 there are chapters on grade and alignment, sections, drainage, foundations for broken stone roads, top courses and their maintenance, minor points (including guard rails, retaining walls, curves, etc.) and materials. Part 2 opens with a chapter on surveys, which is followed by one on office practice. Succeeding chapters deal with cost data and estimates, notes on construction and specifications.

Since the publication of the first edition of the handbook many advances have been made in highway practice. The latest edition, therefore, brings the information up to date. Engineers will find this volume a compact and complete source of information ordinarily required in field and office practice of road-building.

Waterworks Handbook

Compiled by A. D. Flinn, deputy chief engineer, Board of Water Supply, New York City; R. S. Weston, professor of public health engineering, Massachusetts Institute of Technology, and C. L. Bogert, assistant engineer, Board of Water Supply, New York City. Flexible cloth, 6 x 9 in.; 824 pages; illustrated. New York, McGraw-Hill Book Company, Inc. $6 net.

REVIEWED BY WESTON E. FULLER

Consulting Engineer, New York City

This book is a compilation of a large amount of valuable information on matters relating to the design, construction and operation of waterworks. The subject is treated under five parts, as follows: Part 1, Sources of Supply; Part 2, Collection and Work Therefor; Part 3, Transportation by Aqueducts, Pipe and Other Conduits; Part 4, Distribution, Hydrostatics and Hydraulics, Materials Much Used in Waterworks; Part 5, Character and Treatment of water.

This arrangement, while it leads to some repetition and to the separation of some subject matters closely related, is in general a satisfactory one.

The authors have included much data and information selected from a large variety of sources. Extracts from books, papers and periodicals have been used in many cases, with explanatory notes and comments. In other cases, a digest of the subject has been given. References are included quite generally, thus materially adding to the usefulness and value of the book.

As is inevitable in a work of this sort, much that is pertinent to the subject and which to others would appear of equal importance to that included is omitted. Generally, however, the matters presented are well balanced, and give the different viewpoints as fairly as can be expected within the limited space available.

It is noticeable that the authors have not limited the contents of the book to matters which are recognized as established practice, but have on the contrary laid particular stress on recent developments in the science, and have discussed matters that are under investigation and about which much difference of opinion now exists. In some cases the desire to give the latest information has perhaps led to a neglect of fundamentals which are of greater importance. In the main, however, the book presents an excellent idea of recent development.

The book is well illustrated, and is replete with tables and diagrams of value. Some of the data and tables would be useful to only a limited extent, as they are based on methods that would not be of general application. The book includes descriptions of special apparatus and appurtenances, with the names of some of the makers.

The book is written for those who are thoroughly familiar with the fundamentals of waterworks construction and who have a working knowledge of the mathematics, hydraulics and other natural sciences involved in waterworks problems. To these it will prove of the greatest value in the design, construction and operation of these works. The volume will also be of use to those whose connection with waterworks is less close, as it contains much general information.

The portion of the book relating to materials, to hydraulics, to dams and many other matters will prove of value to others than those interested in waterworks, as the information is equally useful for other works.

Location of Road Material Bases Help Contractors Bid

Successful Bidders Furnished Map of Bridges and Culverts, Size and Quantity of Material and Other Necessary Data

CONTRACTORS bidding on the recent road contracts in Vermilion County, Illinois, were furnished with complete detailed plans and in addition a map showing the location of approved material bases in the adjoining State of Indiana, whence most of the aggregate for the concrete will probably come. This map showed all the railroads and connections to points in Vermilion County.

Since the award of contracts the successful bidders have been furnished with all necessary and convenient data in blueprint form cut to the size of pocket notebook sheets. All bridges and culverts, together with the size and quantity of materials required, are noted.

P. C. McArdle is the superintending engineer in charge of this $1,500,000 bond-issue road construction. It will provide a complete system of 166.2 miles of hard roads which it is estimated will carry 80 per cent of the country road traffic.

Total of 1,175,000 Acres of Land Segregated to Wyoming Under Carey Act

Upon the recommendation of the Secretary of the Interior, President Wilson has approved a contract between the United States and the State of Wyoming, providing for the reclamation by the state under the Carey Act of 1680 acres of arid land. This act provides for the segregation of public lands therein to a state for a period of years, provided the state presents a feasible plan for their reclamation through irrigation. With the addition of this new allotment there are now approximately 1,175,000 acres of land segregated to Wyoming, of which more than 150,000 acres have been reclaimed.

HINTS FOR THE CONTRACTOR

Details Which Save Time and Labor on Construction Work

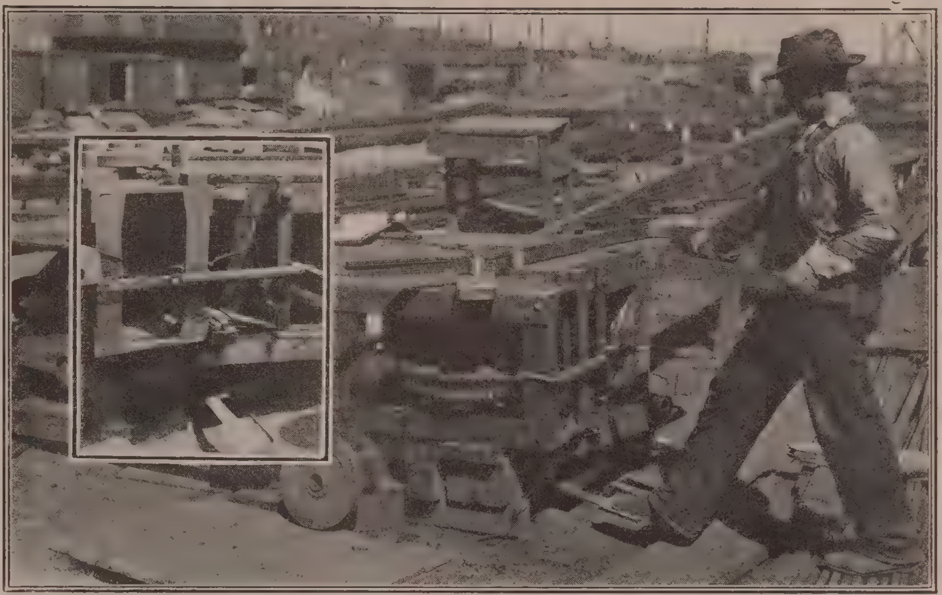
Other articles in this issue of interest to contractors and construction engineers are indexed in the Table of Contents

[*Contributions to this section are solicited, and if found available will be paid for. They must be* SHORT, *and should be accompanied, if possible, by photographs or sketches.*—EDITOR.]

Power Machine Made on Job Bends Reinforcing Bars Around Disk

By HAROLD E. KETCHUM

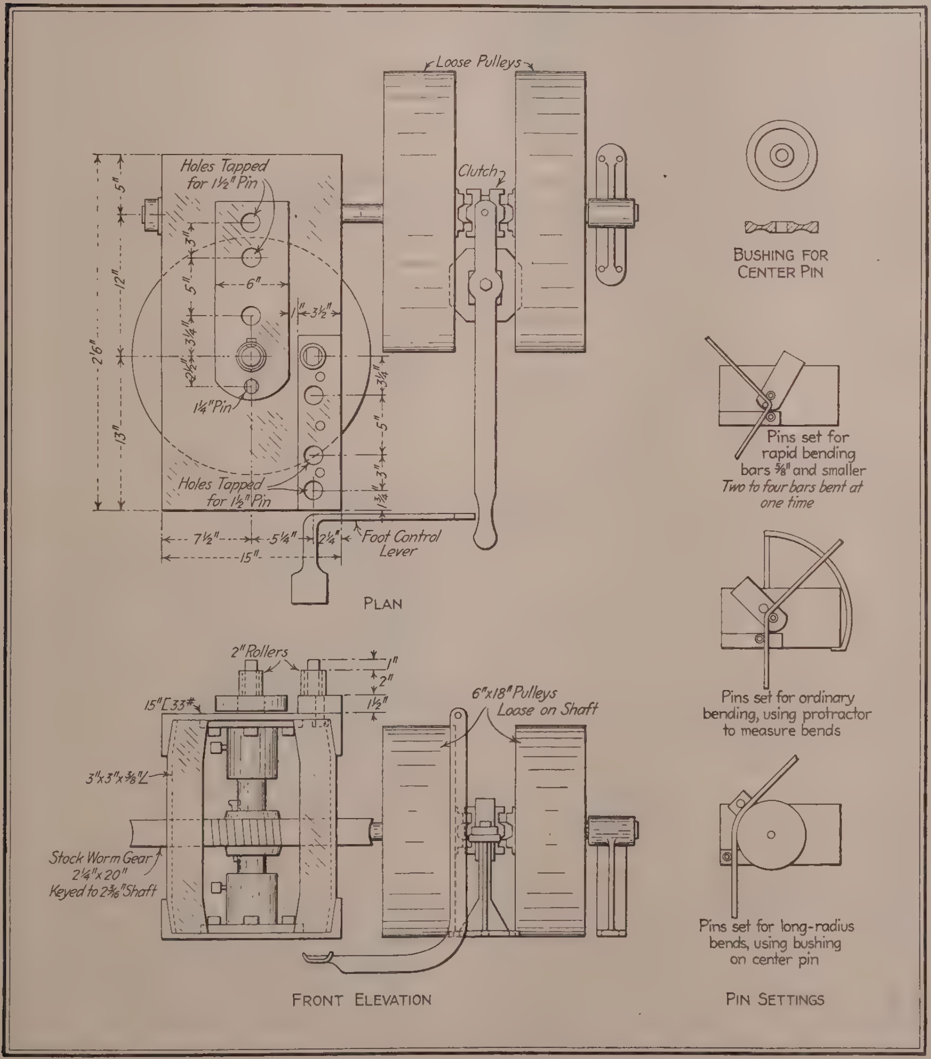
Superintendent Hunkin-Conkey Construction Company, Cleveland, Ohio



HANDLING FOUR FIVE-EIGHTHS INCH BARS AT ONCE—INSERT SHOWS OPERATING DEVICE BY WHICH HEAD IS STARTED OR REVERSED WITH FOOT, LEAVING HANDS FREE FOR BARS

A STEEL-BENDING MACHINE built on the work which is controlled by foot lever, leaving the hands free to handle the bars, is shown in the photograph and drawing. The machine is being used by the Hunkin-Conkey Construction Company on the Detroit-Superior bridge in Cleveland. It makes short bends, for which the end of the bar is caught by a projection on a revolving arm and bent around the spindle, and also long-radius bends for which a cast-iron disk, around which the bars are bent, is placed over the spindle. The machine is operated by a 3-hp. alternating-current motor, driving by belt in opposite directions two pulleys mounted loose on a shaft on each side of a clutch. The worm on the shaft drives the reversible head. The machine can make bends in 1½-in. square stock. Two ¾-in. or four ⅝-in. bars may be bent at the same time.

Three men can handle the steel and make four bends per piece in 110 floor-slab bars ¾ in. by 17 ft. 6 in. in one hour. On this basis the cost of this class of bending amounts to about 50 cents per ton. The control is arranged so that when the operator steps on the foot treadle the horizontal clutch lever shown in the drawing and the insert photograph is pushed to the right, engaging the clutch with the left pulley and revolving the reversing head clockwise. To reverse, the hinged wooden dog, which would otherwise hold the clutch in neutral position when the operator takes his foot off the treadle, is lifted by the string shown. This allows the horizontal spring to pull the clutch lever to the left, engaging the right pulley and reversing the head. To stop the machine and take the bars out, the operator steps on the treadle, depressing it till the dog falls in place, and then releases it, which leaves the clutch locked free of both pulleys. The machine was built of standard channels, angles and gears at a cost of $200.


Loose Pulleys
Holes Tapped for 1½" Pin
Clutch
5"
3½"
12"
6"
5"
3½"
2'6"
3¼"
2½"
3¼"
1¼" Pin
13"
5"
3"
Holes Tapped for 1½" Pin
1¾"
7½"
5¼"
2¼"
15"
Foot Control Lever
PLAN
BUSHING FOR CENTER PIN
Pins set for rapid bending bars ⅝" and smaller
Two to four bars bent at one time
Pins set for ordinary bending, using protractor to measure bends
Pins set for long-radius bends, using bushing on center pin
PIN SETTINGS
2" Rollers
1"
2"
1½"
15" [33#
6"x18" Pulleys Loose on Shaft
3"x3"x⅜" L
Stock Worm Gear 2¼"x20" Keyed to 2 3/16" Shaft
FRONT ELEVATION

MACHINE THAT BENDS ALL THE REINFORCING FOR THE DETROIT-SUPERIOR VIADUCT

How Sheet Pile Structures Can Be Made Tight

SIR: Answering the questions in order as found on page 242 of Engineering Record for Aug. 19 last from the standpoint of experience with Lackawanna steel sheet piling:

1. Is there any difference between the watertightness of new and reused sheeting?

There is no appreciable difference where the re-used piling is in good condition, and even where slightly bent trouble is seldom experienced from water leaking through. In general, if Lackawanna piling is usable at all it is sufficiently watertight for most purposes.

2. Should the sheeting be stretched tight from the inside of the cylinders by wedging against the bracing, or should they be tightened from the outside by putting a cable with a turnbuckle around them at the top, and by the outside water pressure when the cylinders have been pumped out?

It does no harm to stretch the piling tight, but it is seldom necessary. The pressure of the water against the piling automatically tends to seal the joints, and if the piling is driven in mud or sand the tortuous path through the joint and the three lines of contact soon seal the joint effectively.

3. Is it necessary to calk the joints? If so, is there any better method than the use of sand or sand and flour?

Almost everything has been used successfully for this purpose—rope, cinders, manure, coal dust, wood pulp, etc. Where the piling is to remain in place permanently, cement grout is generally used.

4. What is the best way to make a long straight line of sheeting watertight?

Drive to bed rock or to stiff soil and then take care of the leaks, if there are any. The methods have already been stated.

5. What type of pump has proved best for unwatering such cylinders?

On some jobs pulsometer type pumps are used for keeping the water level down during working periods. If the coffer fills overnight due to leaks under the piling, as is often the case, a centrifugal pump is used in the morning for emptying quickly.

N. G. NEAR.

New York City.

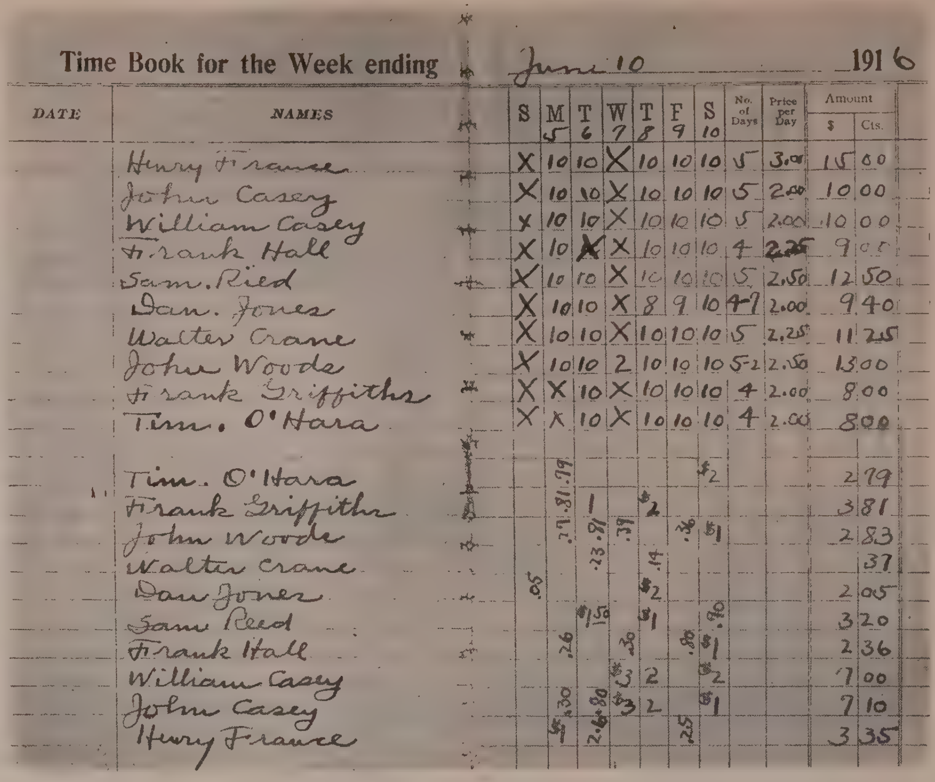
Foremen Keep Time and Deductions on Small Scattered Jobs

By F. D. BUFFUM
Pittsburgh, Pa.

IN THE writer's line of work in this section contractors advance their men money and commissary credit daily to the full extent of the man's earnings, and requests for advances come at all hours of the day. Many men draw their pay as fast as it is made.

The system shown by the accompanying pages taken from an ordinary time book was devised to make it possible to tell at a glance how much of an advance any man is entitled to receive. The time book is always handy in the foreman's pocket, and no office records have to be consulted before making or refusing an advance. But for this method, the practice referred to would make it necessary to have a bookkeeper on every small job. The system has been used for two years on jobs employing up to 40 men and might be made to answer on larger work.

When a man is given an advance, the amount is written under the date opposite the second entry of his name. If written right side up with a dollar sign, it means that he has been given cash. If written without the dollar sign, the entry represents coupon books or scrip. The figures lying on their sides show charges made for any other reason. At the same time, the foreman or timekeeper writes the man's name, the amount, purpose and form in which advanced, with the date, on a small slip of paper torn from a pad which is carried with the time book. After being checked with the entry in the time book, this slip is hung on a spike file at the job for reference in case of dispute. Of course the memorandum slips may be itemized further, and some forms of coupon books have blank receipts to be signed and torn out which may be used instead of the slips. Many of the men who turn in time and deductions with this system could not be depended upon to keep accounts in the ordinary sense. Also, being able to tell a man at once the state of his credit produces a good effect.



Time Book for the Week ending June 10 1916

DATE	NAMES	S	M 5	T 6	W 7	T 8	F 9	S 10	No. of Days	Price per Day	Amount $	Amount Cts.
	Henry France	X	10	10	X	10	10	10	5	3.00	15	00
	John Casey	X	10	10	X	10	10	10	5	2.00	10	00
	William Casey	X	10	10	X	10	10	10	5	2.00	10	00
	Frank Hall	X	10	X	X	10	10	10	4	2.25	9	00
	Sam. Ried	X	10	10	X	10	10	10	5	2.50	12	50
	Dan. Jones	X	10	10	X	8	9	10	4-7	2.00	9	40
	Walter Crane	X	10	10	X	10	10	10	5	2.25	11	25
	John Woode	X	10	10	2	10	10	10	5-2	2.50	13	00
	Frank Griffiths	X	X	10	X	10	10	10	4	2.00	8	00
	Tim. O'Hara	X	X	10	X	10	10	10	4	2.00	8	00
	Tim. O'Hara		.79					$2			2	79
	Frank Griffiths		.81	1		$2					3	81
	John Woode		.77	.31	.39		.36	$1			2	83
	Walter Crane			.23		.14						37
	Dan Jones	.05				$2					2	05
	Sam Reed			$1.50		$1		.70			3	20
	Frank Hall		.26		.30		.80	$1			2	36
	William Casey				$3	2		$2			7	00
	John Casey		.30	.80	$3	2		$1			7	10
	Henry France		$1	2.10			.25				3	35

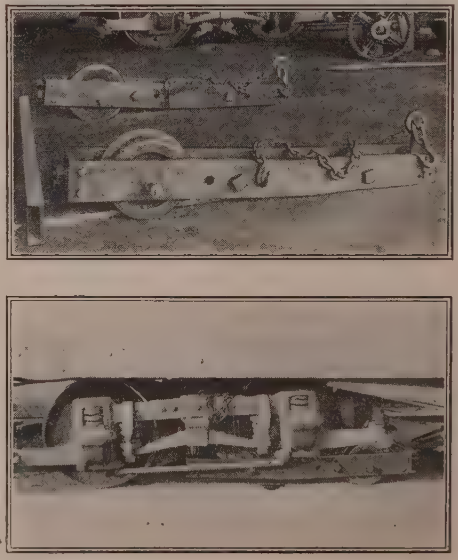
FIGURES WITH DOLLAR SIGN REPRESENT CASH. THOSE WITHOUT THE DOLLAR SIGN COUPON BOOKS, THOSE ON THEIR SIDES OTHER FORMS OF CREDIT

Writing some of the time figures on their sides has also made it easy for these men to separate time worked below the surface from time put in above ground. Private insurance companies on this class of work charged 5 per cent for underground workers and 2 per cent for those who worked above ground. The large difference in these rates made it profitable to keep the two classes of work accurately separated on the time books turned in to the office. Not only were the books kept this way, but the payrolls as well were made out in the same manner, making it unnecessary to have one payroll for surface and a second for underground workers in order to compute the insurance rates accurately.

When the Axle Breaks and You Have to Move the Car

MORE than one construction job has been held up by blocked tracks resulting from a broken axle or wheel on a dump car or crane. While the occurrence is so rare on some classes of work that provision against it would not be justified, on many railroad jobs, or even in some contractors' equipment yards, a device like that illustrated herewith would earn its salt.

This pull-in truck, described in a recent issue of the *Electric Railway Journal*, was made by E. Wright, master mechanic of the Fort Smith (Ark.) Light & Traction Company for bringing disabled trolley cars back to the barn. The emergency truck is made in three pieces, having a pair of bars with a small wheel to run on each rail and a channel to connect them. The disabled car truck is jacked up until the small wheels can be put under it, the rear ends of the bars of the emergency truck are chained up to the frame of the big truck so that they will not drag when the weight comes on them, and the jacks are released, allowing the car wheels to come down on the two pair of bolts, shown in one illustration to the right of the small wheels. In using the device with cars equipped with outside brake beams, it may be necessary to take these off to prevent the brakeshoes from interfering with the small wheels. The wheels on the truck shown have bronze bushings and compression cups for lubrication. When knocked down, the truck occupies but little room, and might be stowed away on a derrick car or a large crane.



THIS DEVICE, WHEN NEEDED, IS NEEDED BADLY

NEWS OF THE WEEK

Passing Events in the Civil Engineering and Contracting Fields

Must Remove Dam in Colorado River by November 1

Irrigation District Given Permission to Build Temporary Structure — Salt Deposits Reason for No Permanent Dams

The Yuma (Ariz.) Water Users' Association has consented to the construction by the Imperial Valley Irrigation District of a temporary dam in the Colorado River at Hanlon's Heading to furnish water for about 400,000 acres of land. The dam has been built and the controversy that has been going on is temporarily ended. The courts ruled that the structure, which had been partly built, must be removed by Nov. 1 and the work of removal must commence not later than Oct. 1. A $100,000 bond was given by the Imperial Valley district to be forfeited if the terms of the agreement are not complied with. The question of building a permanent structure will probably be settled before next spring.

The reasons advanced by the Yuma Water Users' Association against the building of the dam are that "all of the lands are underlaid by a water table which is highly impregnated with deleterious soluble salts, which said water is dependent for its elevation on the relative height of the waters in the Colorado River; the said water table rising in elevation with the rise of the Colorado River and falling with the fall; that if the said water table should be raised in elevation beyond a certain limit of safety, all or practically all of said lands would become entirely uncultivable and valueless, because of an excess of deleterious soluble salts, to the great and irreparable damage of the plaintiffs and all the persons for whom they sue."

Another problem confronting the Imperial Valley Irrigation District is that of disposing of silt deposits which have been accumulating in large quantities. Dredging operations are said to have become more difficult and expensive and the beds of the canal and laterals have risen to an extent to reduce largely their water-carrying capacity.

Bridge Construction Abandoned Due to High Cost of Steel

The freight cutoff bridge to be built over the Delaware River near Trenton, N. J., by the Pennsylvania Railroad has been indefinitely abandoned. The reason for the action is given as the high cost of structural steel. The bridge was one of the Pennsylvania improvements planned for 1914. Work was started on the stone piers, but has not progressed further than that stage. With structural-steel prices so high there is said to be little chance for the structure's completion until conditions are again normal.

Postpone Hearing on Alleghany Bridges

The hearing on the question of raising bridges over the Alleghany River has been postponed from Aug. 31 to Nov. 15. The change was requested by officials of Pittsburgh and Alleghany County.

Irrigation Congress Will Meet When Elephant Butte Dam Is Dedicated

The twenty-third International Irrigation Congress will convene at El Paso, Tex., Oct. 14 and remain in session until Oct. 18. The meeting will coincide with the celebrations attending the dedication of the Elephant Butte dam.

Work of Pennsylvania Water Commission Outlined

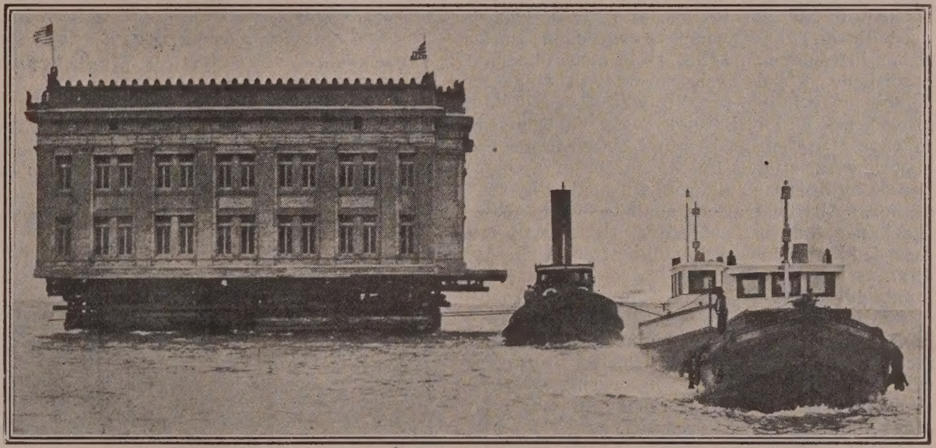
Annual Report Summarizes 1915 Activities and Recommends Conservation of Water-Power Resources

In the annual report of the Pennsylvania State Water Supply Commission made public this week recommendations are made for comprehensive policies in administering the control and use of Pennsylvania streams; for the employment of an adequate engineering staff properly to supervise the construction and maintenance of dams; and that "water, the one remaining great natural resource over which the state has control, be conserved and developed for and in the interest of all the people of the commonwealth." The report covers in detail the various phases of the commission's work. Nine applications for the incorporation of companies to supply water for domestic purposes and three applications for water-power companies were approved. The report states that the number of applications shows a marked decrease.

Summary of Dam Construction

Fifty-one applications for the construction of new dams were considered and forty-three permits issued. Three of the proposed dams exceeded 40 ft. in height and the maximum was 68 ft. Twenty-nine applications to make changes or repairs to existing dams were received and twenty-three approved. The number of existing dams examined was 348, of which repairs and alterations were ordered on 121. The total number of field examinations of dams made was 626. The report, in discussing the dam supervision work, lays great stress on the need for an adequate staff to investigate and report on plans for new dams; to examine and report on all existing dams which by their failure may cause loss of life or property; to inspect dams in course of construction; and to examine from time to time such dams as require inspection to insure their being maintained in safe condition.

Stream encroachments, flood damage during 1915, stream gaging, flood warning, precipitation, inventory of water resources and the Pymatuning reservoir project in Crawford County are discussed in detail. The commission hopes that the general assembly at its next session will make liberal appropriations for hydraulic studies of all streams within the state to determine where stream encroachments are responsible for flood damage.



THE 1000-TON OHIO BUILDING WAS CARRIED THIRTY-TWO MILES ON BARGES

Move 1000-Ton Building Thirty-Two Miles

Ohio Building of Panama-Pacific Exposition Loaded on Barges and Taken to New Site at San Carlos, Cal.

Buildings have been moved from the Panama-Pacific exposition site to permanent locations in surrounding counties by loading them on barges. A white pine bungalow built by the Weed, Red River & McCloud Lumber Company at an approximate cost of $18,000 was one of the first to be moved in that way. It took a week to move the house from the south gardens of the exposition to the yacht harbor —a distance of less than 1 mile—for transfer to the barge. Loading on the barge was difficult owing to the rise and fall of the tide, which is about 9 ft. at that point, and necessitated quick work on the part of the movers to prevent damage to the 160-ton structure as it left the shore. After it was loaded the 15-mile journey across the bay to Santa Venetia, a suburb of San Rafael, was made in about six hours.

The largest and heaviest structure moved was the Ohio Building, which is 132.5 ft. long, 80 ft. wide and 43 ft. high. Its estimated weight is approximately 1000 tons. Two 600-ton barges were placed on ways so that they were entirely out of water at low tide and the building was moved onto them. They floated off at high tide. Owing to the choppy sea beyond the Marina, the barges were moored to the transport dock near by until the following morning and then towed about thirty-two miles down the bay to San Carlos. The building will be used as a home for the Peninsula Country Club. The George Washington home and the Wisconsin Building are to be moved in the same manner.

Herbert L. Hatch has the contract for moving the structures, which is done under the direct supervision of his foreman, A. W. Davis.

Municipal Men Can Attend Two Conventions in One Week

The annual convention of the Society for Street Cleaning and Refuse Disposal will be held Oct. 13 and 14 in the offices of the Department of Street Cleaning, New York City. The American Society of Municipal Improvements will convene Oct. 9-13 in Newark, N. J. The dates and places for the two meetings have been so selected that members of both societies can attend the conventions.

Prizes Offered for Best Papers on Plumbing Practice

Prizes amounting to $200 have been offered by the Cast-Iron Soil Pipe Makers' Advertising Association for papers on the practice or theory of plumbing. They are to be known as the Nelson prizes, in honor of N. O. Nelson, a manufacturer of plumbing supplies, and may be competed for by students or instructors in Harvard University, the Massachusetts Institute of Technology or by any one else who has had training or practical experience in house drainage. Each contestant should send his name, qualifications and the subject of his proposed paper to the committee in charge by Nov. 1, 1916. The chairman of the committee is George C. Whipple, professor of sanitary engineering, Harvard University, Cambridge, Mass. Notice of the approval of the qualifications and subject selected will be promptly returned by the committee. The completed papers must be in the hands of the committee by April 1, 1917. Papers submitted shall contain not more than 5000 words unless special written permission to submit a longer paper has been received from the committee.

The papers submitted may deal with the general arrangement or with selected details of waste, soil, drain, vent-pipe or rain-water conductor systems of buildings as installed under public regulations, or with fixture connections to the pipe system, or with materials used in any of the above-mentioned work either in common practice or to meet unusual conditions. The desire is especially to bring out defects of existing practice and feasible improvements therein. Special weight will be given to papers presenting original observations or experimental studies by the author or accompanied by figures or diagrams prepared by the author. All illustrations shall be bound with the paper that is submitted. Prizes will be awarded as soon as possible after April 1, 1917.

In addition to Professor Whipple, the committee in charge consists of Gifford Le Clear, of Densmore & Le Clear, engineers and architects, Boston, Mass.; Dwight Porter, professor of hydraulic and sanitary engineering, Massachusetts Institute of Technology, Cambridge, Mass., and Harry Y. Carson, Central Foundry Company, New York City.

Brick-Pavement Conference at Paris, Illinois, October 6

The National Paving Brick Manufacturers' Association will conduct a study and conference in brick-pavement construction Oct. 6 at Paris, Ill. Headquarters will be maintained at the Deming Hotel, Terre Haute, Ind., from which place those participating will go via the Interurban Railway to Paris—an hour's ride —where the construction demonstration will take place. The demonstration will consist largely of steps showing the economy of construction details in building a brick pavement by laying the brick in green mortar. An effort will be made to show how such a pavement can be built with the least possible cost and yet maintain all the essentials of worth.

All persons connected in any way officially or those deeply interested in the roads of this country will be made welcome at this conference. The announcement states that the conference is undertaken no less in behalf of the brick industry than in the sincere belief that the country itself is bound to be benefited by such an opportunity. It is pointed out that the money expenditure for roads is so great that a deep interest as to their economic value is manifest everywhere by chambers of commerce and automobile clubs, and that this occasion will afford bodies of this character an opportunity to make a careful investigation and examination of the merits of this kind of road that cannot be gained in an ordinary inspection trip.

All expecting to attend are requested to notify the secretary of the association, Will P. Blair, Cleveland.

Alteration of Engineering Societies' Building Started

Work has been started on the alteration of the Engineering Societies' Building in order to provide room for the American Society of Civil Engineers. A two and a half story addition is to be made to the present structure. The existing framework was designed for only the present loads and it is necessary, therefore, to carry four new columns through the entire thirteen stories. The loads will be carried to these columns by an ingenious truss system, from which the new stories will be hung.

Santa Monica, Cal., to Buy Waterworks

The Santa Monica Water Company has filed with the California Railroad Commission an application for authority to sell its system to the city of Santa Monica, Cal. The price is quoted as $402,500, for which sum bonds have been voted.

May Build $1,000,000 Bridge at Buffalo

The U. S. House of Representatives Aug. 29 granted permission to a committee of nine citizens of Buffalo, N. Y., to construct a toll bridge across the Niagara River in or near that city. The proposed structure will cost about $1,000,000.

Waterways Association Meets at Philadelphia in September

The ninth annual convention of the Atlantic Deeper Waterways Association will be held Sept. 12-15 at Philadelphia. In addition to the regular business an inspection trip will be made to the riverfront and local industrial plants.

Issue Bulletin of Lake Survey

The United States lake survey office at Detroit has just published Supplement 4, containing corrections and additions to Bulletin 25, showing results of surveys of northern and northwestern lakes. The information supplements that given on charts of the Great Lakes.

County Superintendents to Meet

The meeting of the New York State Association of County Superintendents of Highways will be held Sept. 13 and 14 at Syracuse and not Sept. 14 and 15 as stated in last week's issue.

Adds Architectural Engineering Course

The University of Arizona has added a four-year course in architectural engineering to its curriculum, effective this year. L. A. Waterbury, professor of civil engineering, has also been given the title of professor of architectural engineering.

Defer Power Dam Bill

Conferees of the U. S. Senate and House of Representatives working to reconcile differences in the Shields bill to permit construction of power dams in navigable streams by private companies, last week gave up all hope of agreement at this session of Congress. The question will again come up for discussion late in November.

Collects Figures on State Highway Tax

Anticipating the defeat of the Egan road bill in the referendum vote at the November election, the New Jersey commissioner of roads has begun collecting figures on a possible state tax for highways. The Egan bill provides for a $7,000,000 bond issue, but the state department's investigation showed that an outlay of more than $15,000,000 would be required to carry out the program it involves.

Decide Employing Road Engineer Is Economical Investment

The good-roads committee of the Chamber of Commerce of Oklahoma City, Okla., recently decided to employ an expert highway engineer to direct road construction in that vicinity. Parts of an editorial on the action in the *Daily Oklahoman* read as follows:

"It is recognized that building good roads is a matter of engineering and that different localities require different planning and constructing. A great deal of money has been lost in road-building simply because the work was not under trained direction.

"One of the simplest things in a good-roads movement anywhere is getting the money. Getting the best results for the money is quite another thing. A county over in Texas some two or three years ago happily hit upon that fact. It voted a tremendous good-roads bond issue, somewhere up among the millions. Profiting from the sad experiences of other enthusiastic communities it engaged a man who had made a distinguished record as a city street builder. It paid him a big salary, as of course it had to do, but that proved a wise investment. It got the results.

"The judgment of the Chamber of Commerce in getting a capable, experienced man for such a big job is sound. It is on the right road for good roads."

Engineering Society Activities

The San Francisco Association of Members of the American Society of Civil Engineers held its regular bimonthly meeting at the Palace Hotel, Aug. 15. George Lincoln Dillman briefly discussed the chief cause of trouble and the basic reason for human progress.

The Detroit Engineering Society conducted an inspection trip Aug. 16 to the plants of the Detroit Steel Products Company, the Michigan Smelting & Refining Company and the Aluminum Castings Company. The first fall meeting will be held Sept. 15.

The Connecticut Society of Civil Engineers gathered in New London Aug. 8 for the midsummer outing. More than 125 persons visited the new state pier, the submarine base and the work being done on the new Thames River bridge.

The Providence Engineering Society will occupy its new rooms at 29 Waterman Street, Providence, R. I., next September. The entire second floor of the building has been remodeled.

The Chicago Engineers' Club held a dinner Aug. 25 in honor of G. A. M. Liljencrantz, who is retiring from the engineering department of the U. S. War Department after forty-five years of service. Mr. Liljencrantz, as the club's invitation to the dinner read, will "return to his native Sweden to enjoy the evening of his days with his own people. We wish to show our appreciation of the man and to speed him on his way."

The Engineers' Club of Seattle recently entertained as its guest L. M. Grant, chief engineer of the Pacific Coast Pipe Company, who addressed the meeting on the uses of wood-stave pipe and its limitations.

The Engineers' Club of Seattle on Aug. 14 entertained at a luncheon at the Hotel Butler Director Manning, U. S. Bureau of Mines, who came to Seattle to consider the application of the University of Washington for the establishment of one of the ten mining stations of the bureau. Dr. Henry Suzzallo, president of the university, also addressed the meeting, which was presided over by Judge Thomas A. Burke of Seattle.

The Northwestern Branch of the American Society of Civil Engineers will meet Aug. 26 at Duluth. Inspection trips will be made to local points of engineering interest.

What Engineers and Contractors Are Doing

Dr. William McClellan, consulting engineer, of New York City, and former chief engineer for the New York Public Service Commission for the Second District, has been appointed dean of the Wharton School of Finance and Commerce of the University of Pennsylvania. Dr. McClellan was graduated from the arts department of Pennsylvania University in 1900. During his college course he received the Quaternions Prize, was elected a member of both Phi Beta Kappa and Sigma Xi honorary fraternities and received special honors in mathematics. Later he obtained the degree of doctor of philosophy in physics, mathematics and philosophy. For a time Dr. McClellan was engineer in charge of construction for the Philadelphia Rapid Transit Company. In 1905 he was appointed supervising engineer for Westinghouse Church Kerr & Company, and in 1907 became associated with H. T. Campion, consulting engineer, of Philadelphia. In 1911 he was appointed electrical engineer and chief of the division of light, heat and power of the Public Service Commission of the Second District of New York State. Dr. McClellan is a fellow and vice-president of the American Institute of Electrical engineers, a member of its executive committee and vice-chairman of its public-policy committee. He is one of the two representatives of the institute on the joint conference committee of engineering societies and is also president of the joint Pan-American engineering committee. He has always been interested in steam-railroad electrification and was for a number of years chairman of the electrification committee of the New York Railroad Club. As a member of the New York board of directors of the Naval Consulting Board he is also actively engaged in the work of national preparedness.

Pierce J. Landers, who was recently made superintendent of the Indianapolis Union Railway, has been with that road since 1902. He entered railway service in 1888 as rodman for the Pennsylvania Railroad and was later promoted to superintendent's clerk, draftsman and assistant engineer. After ten years' service with the Pennsylvania Mr. Landers resigned to take a position as roadmaster of the Wisconsin Central Railway, from which position he was promoted in 1900 to become division engineer. His service with the Indianapolis Union Railway started in 1902, when he was appointed assistant engineer. He was promoted to engineer maintenance of way five years later, retaining the position until his recent appointment.

T. R. Ratliff has been appointed engineer maintenance of way of the Indianapolis Union Railway, succeeding P. J. Landers, whose promotion is noted elsewhere in this issue.

C. E. Grunsky, of San Francisco, and **George G. Anderson**, of Los Angeles, have been chosen by the directors of the Imperial Valley Irrigation District to act with W. F. McClure, state engineer of California, as an advisory board to consider the various engineering problems of the district. Mr. Anderson has removed his office to the Consolidated Realty Building.

Oliver F. Starr has resigned as president of the Green-Starr Engineering Company to open consulting offices at 1530 Chestnut Street, Philadelphia. He will specialize on sewerage and sewage-disposal problems.

Blum, Weldin & Company, engineers, of Pittsburgh, have acquired all of the plans, notes and records belonging to Hudson F. Layton, civil engineer, of that city, who is retiring from practice. The addition of the data covering the practice of Mr. Layton and of the firm of Browne & Layton will greatly increase the facilities for service of Blum, Weldin & Company.

Col. S. W. Roessler, Corps of Engineers, U. S. A., who was placed on the retired list last year, has withdrawn from active engineering work. He is now at Bridgeport, Conn. Colonel Roessler was graduated from West Point in 1881 and was made colonel in 1909.

John F. Vaughan has opened an office at 185 Devonshire Street, Boston, Mass., for the practice of consulting engineering. He has been retained by the Boston banking house of Estabrook & Company in connection with the re-development of a 20,000-kw. hydroelectric plant at the Sault Ste. Marie, Ont. Mr. Vaughan has been associated with the Stone & Webster Engineering Corporation of Boston for about fifteen years, prior to which he was engaged in pioneer electrification work on the New York, New Haven & Hartford Railroad under the late Col. N. H. Heft. He has been active in transmission and hydraulic work and has served as chairman of the hydraulic branch of the N. E. L. A. committee on prime movers. He is the inventor of the Vaughan hydraulic flow meter.

P. J. Freeman has resigned as assistant professor of applied mechanics in the Kansas State College to become associated with the Pittsburgh Testing Laboratories as engineer of tests.

F. N. Graham, formerly assistant engineer for the Chicago & North Western Railway, has been appointed assistant engineer of construction on the new ore dock 6 at Duluth Minn., for the Duluth, Missabe & Northern Railway. Mr. Graham is a graduate of Rensselaer Polytechnic Institute, class of 1898, and was assistant engineer on the Chicago and North Western terminal in Chicago.

L. A. Granger resigned Sept. 1 as assistant city engineer of Fresno, Cal., to engage in private practice in that city. Prior to May, 1915, when he became assistant city engineer, Mr. Granger had served as a locating engineer in South America for an American mining syndicate. He has also been connected with a number of Eastern railroads as consulting engineer.

J. K. McGrath, formerly assistant engineer in charge of paving work in Baltimore, Md., has resigned from the city employ to become engineer in charge of new road work in Fayette County, West Virginia.

George F. Wieghardt, of the Pennsylvania Water Supply Commission, was appointed principal assistant engineer of the water department of Baltimore, Md., Sept. 1. He will have charge of the maintenance and construction division.

William H. Boardman, engineer for the New Jersey Water Supply Commission, has been appointed resident engineer on the survey for the proposed water supply from the Wanaque River watershed. The field party is now making a survey of the proposed site, with headquarters at Midvale. Mr. Boardman has been actively engaged in water-supply engineering in New Jersey since 1911, spending a year with Morris R. Sherrerd on reservoir work. He was graduated from the University of Maine in 1901 and from then until 1911 was employed on concrete dam and building construction.

Frederick Holbrook, president of the Holbrook, Cabot & Rollins Corporation, has been elected a vice-president of the American International Corporation and will, in a few days, make a tour of Russia as the representative of the latter firm. Hr. Holbrook will make a thorough investigation of a number of possibilities in Russia, including the financing and construction of new railroads, mines, power installations and other industrial projects.

Obituary Notes

Thomas H. Stryker, a retired civil engineer and business man, of Rome, N. Y., died last week in that city at the age of 69. Although he had not taken an active part in business since 1900, Mr. Stryker was interested in many of Rome's large industries, including the Rome Iron Works, the Rome Brass & Copper Company and the Rome Gas, Electric Light & Power Company. He was born in Rome in 1847 and was graduated from Hobart College in 1868. Immediately thereafter he studied abroad, returning to manage the affairs of his father, John Stryker, who was interested in the organization of several railroads, including the Lake Shore & Michigan Southern. Mr. Stryker was appointed city engineer of Rome in 1876 and was later active in the building of the Rome & Clinton Railroad. He was also chief engineer on the survey for the Boston, Rome & Oswego Railroad, assistant engineer on the Champlain canal and engineer under the state engineer in charge of improvement of the Hudson River. In 1881 he was made secretary and treasurer of the New York Locomotive Company and later elected to its presidency, in which office he continued until the firm passed out of existence. He retired from active business life in 1900.

Anthony Walsh, who was prominently identified with the construction of the Rock Island Southern Railway in Iowa, died Aug. 28 in San Francisco in his eighty-fourth year.

John Dean, a retired civil engineer and contractor, died Aug. 17 at his home in Chicago. He received his engineering education at Owens College, Manchester, England. Coming to the United States in 1885, he engaged in engineering work successively with the Chicago, Rock Island & Pacific Railway, the Frisco Lines and the Wabash Railroad. He was also engineer of parks for the City of St. Louis, Mo. As a contractor he did extensive work in grading and concrete bridge construction, first in the South and later for the Grand Trunk Railroad and the cities of St. Louis, Mo.; Manistee, Mich., and Des Moines, Iowa. He was for many years a member of the Engineers' Club of St. Louis and of the American Railway Engineering Association.

Civil Service Examinations

Minnesota — Unassembled examinations will be held Sept. 18 for sidewalk engineer and Sept. 22 for engineering assistant. Salary for each position is $100 to $125 a month. Resident requirements waived. Further information may be obtained by writing the civil service bureau at St. Paul.

United States—Examination will be held Oct. 3 for senior highway bridge engineer, salary $2,400 to $3,300. Another for highway bridge engineer, salary $1,800 to $2,100, will be held Oct. 4. Form 1312 should be filled in by applicants for these positions. Examinations will be held Oct. 4 for junior civil engineer, grades 1 and 2 (salaries $1,200 to $1,680 and $720 to $1,080) and for junior structural engineer at salary of $720 to $1,680. Form 2039 should be filled in by applicants.

Examinations Previously Announced

Date		See Eng. Record
Sept. 5.	Subinspector U. S. radio towers	Aug. 19
Sept. 6 and 7.	U. S. structural-steel draftsman	Aug. 19
Sept. 13.	Aid in Coast and Geodetic Survey	Aug. 5
Sept. 13 and 15.	Assistant examiner, patent office	Aug. 26
Sept. 19.	U. S. Mechanical draftsman	Aug. 26
Oct. 11.	U. S. junior civil engineer	Aug. 19

Simplifies Engineering and Contracting Computations

The diversity of engineering and contracting calculations and the great amount of mental effort wasted in arriving at accurate solutions have created a strong demand among engineers and contractors for relief through mechanical means. The Monroe calculating machine, which was placed on the market about four years ago, seems particularly fitted for the solution of their problems.

The machine has a standard flexible adding-machine keyboard for setting up the numbers to be added, subtracted, multiplied or divided; a crank for performing the operations and a carriage holding the dials which show the results and the proof of the operations as they are performed.

The use of the machine requires no special training. Every operation carries a constantly visible check on the accuracy of the work. An error can be immediately detected and corrected by either a forward or a reverse turn of the operating lever.

COMPUTING MACHINE USEFUL TO ENGINEERS

To illustrate the adaptability of the Monroe to engineering work, suppose the length of the hypotenuse of a right-angle triangle whose sides are 21 and 28 ft. long is to be found. This calculation is performed by setting up 21 on the keyboard, squaring, adding the square of 28 and extracting the square root of the total (1225). The whole operation only requires 8 sec. and no mental effort is involved.

The following concrete-girder computations can be done on the Monroe with a check as to accuracy in 40 to 50 sec., whereas to solve them with pencil and paper would require four or five times as long and then there would be no proof of accuracy:

$$K = \sqrt{(2 \times 0.00769 \times 15 + [0.00769 \times 15]^2)} - 0.00769 \times 15 = 0.379$$

The machine, of course, is equally adaptable to the simpler computations, such as the making out of payrolls, the figuring of percentages, the computation of costs, billing, etc.

Beside being used extensively by large industrial companies the following engineering firms, among others, have installed the machine: Henry L. Doherty & Company, Bing & Bing, W. J. Wilgus, Viele, Blackwell & Buck. Henry L. Doherty & Company state that the machine is especially useful in computations where unit figures are to be found. "For multiplying and dividing," they say, "we find it the best machine we have ever used."

The machine is manufactured by the Monroe Calculating Machine Company, with offices in the Woolworth Building, New York City.

Welding and Cutting Handbook

Lessons in use of equipment and operations necessary to oxyacetylene welding and cutting. Compiled by Imperial Brass Manufacturing Company, Chicago. Fifty-six pages; illustrated; paper binding. $1 net.

Preceding the detailed description of the proper use of oxyacetylene-welding tools are a few pages outlining the principles of welding and the care of equipment. The effects of expansion and contraction are discussed and the chemical action and mechanical effects of the flame explained. Pages 21 to 42 inclusive are devoted to details of welding operations and also contain lists of metals that cannot be welded.

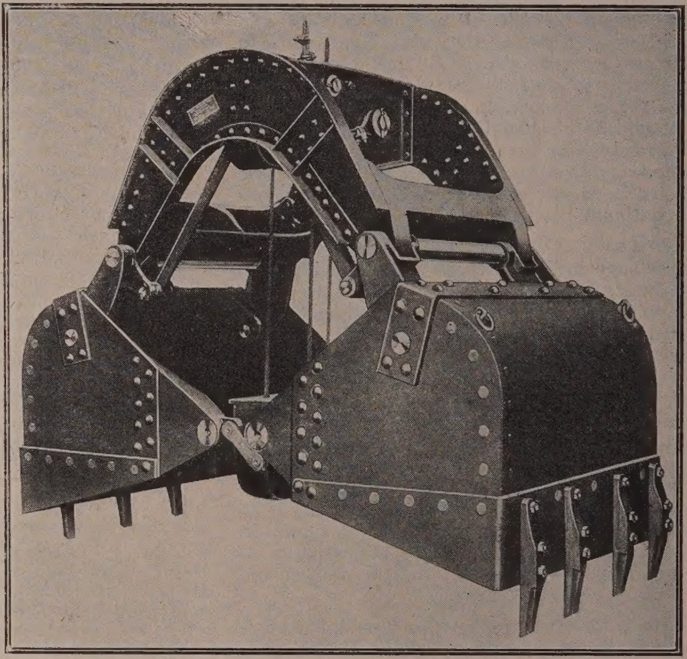
Two pages suggest a cost-keeping method, following which the oxyacetylene-cutting process is described. The oxyhydrogen process is also mentioned. The equipment manufactured by the publishers is described and its operation explained.

New Clamshell Bucket Has Steel Arch Yoke

A radical deviation from the usual design of clamshell buckets has been made by the Buffalo (N. Y.) Contractors' Plant Corporation. The design and construction of the Buffalo bucket, as the new device is called, embodies many new features, the most prominent of which is the steel arch yoke. The arch construction gives a maximum rigidity and compactness and a closing power that surprises even the manufacturers. When open the bucket forms a continuous arch of such strength that it may be dropped from great heights to gain entrance into hard material.

The height of the Buffalo bucket is about 20 per cent less than usual. The bowls are joined to central pivots and closing is effected by means of ropes and sheaves without drums or chains. The distance of the closing links from the central bowl pivot is enough, the manufacturers say, to make the closing power unusually great. The design also takes care of tension between the center bowl pivot and the link connection to the bowl (caused by closing) by placing the metal of the bowl directly in the line of that stress.

According to the manufacturers, the Buffalo bucket has given most satisfactory results when tested. They also say that the unusual strength of the device offers new opportunities for contractors in excavating when the ground is hard.



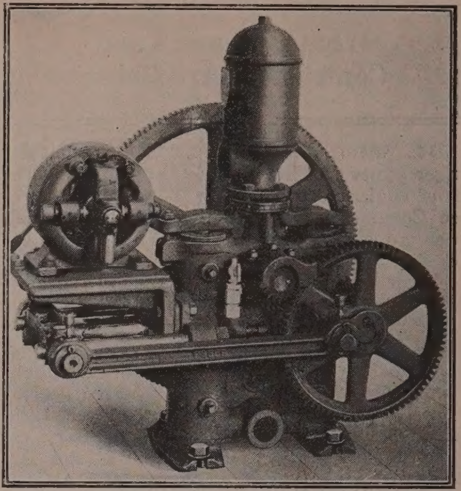
WHEN BUCKET IS OPEN IT FORMS A CONTINUOUS ARCH, AND WORKING PARTS ARE CLEAR OF THE MATERIAL TO BE DUG

C. W. Nash Heads Motor Company

C. W. Nash, formerly president of the General Motors Company, is now at the head of the Thomas B. Jeffery Company, Kenosha, Wis. Mr. Nash announces plans for a big increase in the production of the company he now heads.

Double-Acting Piston Pump Used with Elevated Water Tank

The rapid extension of electric power circuits has made it possible and desirable to have power-pumping equipment for general water supply, fire protection and various other services. To meet such demands the Goulds Manufacturing Company of Seneca Falls, N. Y., has developed a line of single-cylinder double-acting piston pumps, of which the one illustrated is typical. The pump shown is the 2½ x 4 in. size, having a capacity of 6 gal. per minute against elevations up to 100 ft. It is operated by a ½-hp. Westinghouse motor mounted on a bracket attached to the pump to make a compact outfit.



DOUBLE-ACTING PISTON PUMP

The "Pyramid" pump has large and easy waterways and few parts. The base, cylinders, bearings and one cylinder head are cast in one, thus keeping the gearing in line and decreasing wear. The cylinder is lined with brass and provided with large suction valves which are easily accessible through two hand holes. The discharge valves are above the cylinder and reached through handholes at either side of the air chamber.

The outfit illustrated is especially adapted for elevated tank water-supply systems. It can be used for pneumatic tank water-supply systems by employing a separate air pump. Fitted with special valves and gaskets it can be used for pumping gasoline, for which service it has been approved by the National Board of Fire Underwriters.

Truck Company Increases Capitalization

The United States Motor Truck Company of Cincinnati, Ohio, recently increased its capital stock from $300,000 to $1,000,000. The firm was established seven years ago. When it was reorganized in 1914 R. C. Stewart was made president and the capital stock increased to $300,000.